SECOND ANNUAL REPORT
OF THE
CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
FOR THE YEAR
1889.
ITHACA, N. Y.

Furman Lloyd Mulford. F. L. Mulford.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

SECOND ANNUAL REPORT

OF THE

Agricultural Experiment Station.

ITHACA, N. Y.,

1889.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

The Station

Agricultural Experiment Station.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

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L. H. BAILEY, ... Professor of Horticulture.
W. R. DUDLEY, ... Ass't Prof. Cryptogamic Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS, ... Director.
HENRY H. WING, ... Deputy Director and Secretary.
E. L. WILLIAMS, ... Treasurer.

ASSISTANTS.

Agriculture, ... ED TARBELL.
Chemistry . . . . WILLIAM P. CUTTER.
Veterinary Science, ... ——— ———
Entomology, ... JOHN M. STEDMAN.
Horticulture, ... W. M. MUNSON.

Offices of the Director and Deputy Director, 20 Morrill Hall.

TABLE OF CONTENTS.

LETTER OF TRANSMITTAL.

To His Excellency,

The Governor of the State of New York:

SIR:

I have the honor herewith to transmit the Second Annual Report of the Agricultural Experiment Station of Cornell University, in accordance with the provisions and requirements of the Act of Congress, approved March 2, 1887, establishing the Station. This Report consists of the following documents:

1. The Report of the Director of the Station.
2. Acknowledgments of donations.
3. The Report of the Treasurer.
4. The Report of the Chemist.
5. The Report of the Botanist.
6. The Report of the Cryptogamic Botanist.
7. The Report of the Entomologist.
8. The Report of the Agriculturist.
9. The Report of the Horticulturist.
10. Appendix I., containing copies of the eleven Bulletins published in the course ot the year.
11. Appendix II., containing a detailed statement of the receipts and expenditures of the Station.

From the reports of the various officers of the Station it will be seen that the year has been one of productive energy. The Bulletins issued have been received with gratifying favor by the agricultural press of the country. During the year the office has

received more than one hundred and sixty extracts from, or notices of, the Bulletins published by the Station, in several instances the Bulletin having been copied entire. The notices have been so highly commendatory in character that we can have no doubt as to the general favor with which the work of the Station has been received.

I have the honor to be

Your obedient servant,

[Signed] C. K. ADAMS,

President of the Cornell University.

CORNELL UNIVERSITY,

Jan. 30th, 1890.

REPORT OF THE DIRECTOR.

To the President of the Cornell University :

SIR :

I have the honor herewith to transmit the Annual Report of the Cornell University Agricultural Experiment Station, which includes the reports of the Treasurer and Deputy Director and Secretary, together with those of the divisions of Chemistry, Botany, Entomology, Agriculture, and Horticulture; also Bulletins Nos. V to XV inclusive, and a detailed statement of receipts and expenditures for the fiscal year ending June 30, 1889.

The eleven bulletins issued during the year embrace a wide field of investigation. Some of them are of a scientific character, but are none the less valuable on that account. It is impossible to make steady advancement in our investigations without the aid of the knowledge which purely scientific investigation gives.

The Tennessee Agricultural Experiment Station published in June a valuable bulletin on the potato blight. As that disease had appeared in many places in this State, it was decided to purchase three thousand copies and distribute them in the potato growing districts.

The aim has been to give immediate help to those who are seeking for it, so far as we might be able, while at the same time, doing much work in perfecting new methods, and testing and investigating the accuracy of methods now in use, in order that our results may be as perfect as human skill can make them.

There are many indications that the work done in the last year has been of marked and permanent value. The mailing list, home and foreign, has now reached upwards of seven thousand, and is increasing rapidly.

There are not less than five hundred thousand adult men in the State who are directly engaged, to a greater or less extent, in growing animals and plants, and to reach all of these with bulletins would absorb the greater share of our resources, and leave little for doing the work out of which bulletins should naturally grow.

So far this difficulty has been met by the liberal and progressive spirit of the Agricultural Press. It has uniformly shown such a broad and kindly spirit, not only towards the workers of the Station and their investigations, but to the cause of improved agriculture, thereby arousing interest and aiding the Station in getting before the public the results of its work, that I desire here, publicly, to acknowledge the great obligation to it we and our constituents are under.

The policy of aiding the reader to understand and remember the results obtained in our investigations by numerous illustrations, which was begun last year, has been enlarged upon and continued this. It was early found that untrained laborers were illy suited to perform even the most common operations of experiment work without careful and constant supervision. So, for the sake of both economy and accuracy, the common laborer has been largely dispensed with, and the work has been performed by the salaried assistants. This gives the appearance in the financial report of having spent a small amount for labor and a large amount for salaries.

In some branches of the Station work, some difficulty is found in writing the bulletins so that they will be entirely clear to the ordinary reader, because no common or popular names and terms can be found which can be used instead of those adopted by the scientists. We trust that the criticisms and difficulties will gradually disappear, as the readers become more familiar with scientific terms, and we more expert in avoiding and in coining popular substitutes or brief explanatory terms for them.

I. P. ROBERTS,
Director.

We are pleased to acknowledge the receipt of the following donations.

Retsof Mining Co., Piffard, N. Y.—1 bbl. Cattle Salt.
D. H. Burrell & Co., Little Falls, N. Y.—1 Gal. Hansen's Rennet Extract.
D. W. Beadle, St. Catherines, Ontario.—Cuttings of Russian Grape.
V. H. Hallock & Son, Queens, N. Y.—Seeds.
J. M. Thorburn & Co., New York—Seeds.
John G. Gardner, Jobstown, N. J.—Tomato Seeds.
W. O. Shallcross, Locust Grove, Md.—Apple Scions.
Ohio Experiment Station, Columbus, O.—Apple Scions.
Missouri Experiment Station, Columbia, Mo.—Apple Scions.
Edwin Allen, New Brunswick, N. J.—Apple Scions.
W. D. Barnes, Middle Hope, N. Y.—2 Paradox Grape Vines.
J. Laws, Geneva, N. Y.—1 Jennie May Grape.
Farmers' Fertilizer Co., Syracuse, N. Y.—2 sacks Fertilizers.
Per Oxide Silicates Co., New York.—20 lbs. Per Oxide Silicates.
N. Y. State Experiment Station, Geneva, N. Y.—Strawberry Plants.
U. S. Dep't of Agriculture, Washington, D. C.—Seeds; Scions of Kelsey Plum; Specimen of Cocoanut.
Sherman & Crouch, Sydney, N. Y.—Plant Protectors.
Michigan Experiment Station, Agricultural College, Mich.—Tomato Seeds.
T. H. Hoskins, Newport, Vt.—Apple Scions.
H. M. Jaques, Wright's Corners, N. Y.—Apple Scions.
L. H. Bailey, South Haven, Mich.—Apple Scions.
Dr. E. L. Sturtevant, S. Framingham, Mass.—Seeds.
Nauvoo Fruit Growers' Association, Nauvoo, Ill.—Strawberry Plants.
N. Hallock, Creedmoor, N. Y.—Strawberry Plants.
A. W. Smith, Americus, Ga.—Four varieties of Moon Flower.
Alabama Experiment Station, Auburn, Ala.—White Field Corn.
South Carolina Experiment Station, Columbia, S. C.—White and Yellow Corn.
Delaware Experiment Station, Newark, Del.—Apple Scions.
Dakota Experiment Station, Brookings, S. Dak.—Apple Scions.
Foster Udell, Brockport, N. Y.—Apple Scions.
F. L. Peirs, New Providence, Ind.—Crab Scions.
Dr. J. F. Appell, Lake City, Fla.—Two species Wild Garlic; Specimens of diseased Peach root.
Northrup, Braslan & Goodwin Co., Minneapolis, Minn.—Seeds.

REPORT OF THE TREASURER.

The Cornell University Agricultural Experiment Station,
In account with
The United States Appropriation.

1889.	To Balance of Appropriation for 1888 on hand July 1, 1888, ...		Dr. $ 41 91
	To Receipts from Treasurer of the United States, as per appropriation for year ending June 30, 1889, under Act of Congress approved March 2, 1887, ...		$14,958 09
			$15,000 00
		Cr.	
June 30.	By Salaries, ...	$8,335 42	
	" Buildings, ...	750 00	
	" Printing, ...	1,306 63	
	" Office Expenses, ...	436 34	
	" Equipment, Labor and Current Expenses:		
	Agriculture, ...	606 22	
	Horticulture, ...	2,493 53	
	Entomology, ...	260 46	
	Botany, ...	597 13	
	Chemistry, ...	214 27	
			$15,000 00
	Receipts for Produce sold:		
	Agricultural Department, ...	$ 190 87	
	Horticultural Department, ...	103 38	
			$ 294 25

We, the undersigned, duly appointed auditors for the corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of Cornell University for the fiscal year ending June 30, 1889; that we have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000, including unexpended balance of July 1, 1888, and the corresponding disbursements, $15,000, for all of which proper vouchers are on file, and have been by us examined and found correct:

(Signed.) H. B. LORD, GEO. R. WILLIAMS, } Auditing Committee Board of Trustees.

I hereby certify that the foregoing statement of account to which this is attached, is a true copy from the books of account of the Institution named.

(Signed.) EMMONS L. WILLIAMS,
Treasurer.

STATE OF NEW YORK,
TOMPKINS COUNTY. } ss.

On this 31st day of January, 1890, appeared before me Emmons L. Williams, personally known to me to be the person whose signature is attached to the above certificate, and acknowledged that he executed the same.

(Signed.) HORACE MACK,
[L. S.] Notary Public.

REPORT OF THE CHEMIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR :—

I submit herewith a summary of the work of this division of the Experiment Station.

All the actual analytical work mentioned below was done by Mr. W. P. Cutter, the assistant chemist, or under his immediate supervision. The number of analyses to be made was so large that additional help was necessary in the laboratory of the Station during a small portion of the year.

Upon Mr. Cutter, also, devolved the preparation of the samples of fodder to be used in testing methods of analysis, and their distribution to the several Experiment Station Chemists, who consented to make the analyses for the Association of Official Agricultural Chemists; and much time was given by me in the course of the summer to the preparation of the report to the Association on these results, and a complete bibliography of journal literature on methods of analysis of cattle foods. This work appears in the Annual Report of the Association, now going through the press.

The material equipment of the laboratory of the Station is essentially the same as it was at the time of the last report, no important additions having been made.

Yours Respectfully,

G. C. CALDWELL,
Chemist.

LIST OF ANALYSES MADE FOR THE CORNELL UNIVERSITY EXPERIMENT STATION—1889.

Fodders.

48 Samples Fodder Corn.
4 Samples of Corn.
1 Sample Corn Germ Meal.
1 Sample Condimental Cattle Food.
9 Samples for Digestion Experim'ts.
1 Sample Buckwheat Hulls.
1 Sample Sunflower Seed.
3 Samples for the Association of Official Agricultural Chemists.
1 Sample Malt Sprouts.
1 Sample Wheat Bran.
1 Sample Clover Hay.
Total 71.

Fertilizers and Amendments.

6 Samples for the Association of Official Agricultural Chemists.
9 Samples Farm Yard Manure.
1 Sample Soot.
14 Samples Manure Leachings.
2 Samples Ashes.
6 Samples Sheep Manure.
Total 38.

Feeding Experiments.

2 Samples from Sheep.
15 Samples from Pigs.
4 Samples from Chickens.
Total 21.

Dairy Products.

98 Samples Whole Milk.
12 Samples Skimmed Milk.
5 Samples Butter.
1 Sample Cheese.
Total 116.

Summary.

Fodders	71
Fertilizers and Amendments	38
Feeding Experiments	21
Dairy Products	116
Total	246

INCIDENTAL WORK.

The determination of moisture in fodders.
Testing new apparatus for fodder analysis.

W. P. CUTTER,
Assistant.

REPORT OF THE BOTANIST AND ARBORICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station :

SIR :

The work of this division for the present year, so far as the division has any special relation to the Experiment Station, has been devoted wholly to the investigation of the diseases of plants. This work has been carried on by Assistant Professor Dudley, and the results have in part been embodied in one of the bulletins of the Station devoted to the diseases of the strawberry plant.

In the organization of the department with reference to Station work, it was thought that, in addition to the special subject above mentioned, some facts of a more general nature and of minor importance might occasionally be brought out in the ordinary working of the department as a department of instruction in the University, which might possess some interest in their bearing upon agricultural pursuits. A few notes of this kind have been prepared for one of the Station bulletins ; but it should be mentioned that the Station has been to no expense whatever in connection with the experiments on which these notes are based.

The appropriation made to this department from the funds belonging to the Station for the current year has been wholly expended in paying for the work of investigating plant diseases, or in perfecting facilities for prosecuting such investigations. In this connection it should be borne in mind that this special subject, more than most, calls for a large amount of careful and painstaking work, which in its very nature is not productive of material suitable for publication in Station bulletins.

A. N. PRENTISS,
Botanist and Arboriculturist.

REPORT OF THE CRYPTOGAMIC BOTANIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR:

The work of investigation accomplished during the past year is, to a certain extent, indicated in Bulletin XIV., on the diseases of the strawberry plant. But a large amount of time has been consumed in getting under way investigations on the development and habits of several little known parasitic fungi, some of which are indicated below. Correspondence developed the presence of several of these maladies not hitherto recognized in the State, or which have appeared but recently; and work on the fungi infesting the following host-plants is more or less advanced in this laboratory, especial attention being given to the life of the parasite during the winter and spring months:

The Onion.
The Strawberry.
The Cultivated Currant.
The Clover.

Considerable work, also, has been already accomplished on the disease causing the cracking of Quinces and Pears (mentioned in the First Annual Report.) A disease of wheat, caused by a *Cladosporium*, appeared in 1889, in this vicinity, doing much injury; and so far as time permits in the coming spring, this will receive attention. Reports of progress on the above may be published, and from time to time a completed study; but for the completion of biological studies presenting such extraordinary difficulties as the work on the fungi, it is impossible to predict the exact amount of time required. The great aim should be care and thoroughness.

Between four and five thousand specimens of fungi belonging to the Station have been mounted and catalogued during the year. Five cases for the storing of apparatus, reagents, herbarium-speci-

mens and books, and a large table for the various operations of experimental work, with numerous drawers and compartments for working material, have been constructed.

One of the possibly unavoidable limitations,—among those affecting both the quality and quantity of the work in this laboratory,—is that of proper working space. There are needed a small room for instruments and apparatus, one for the operations of sterilizing, etc., and another for artificial cultures, wherein the conditions necessary to such experiments, especially those of temperature, could be controlled. Provision for these would greatly improve the means for successful work.

WILLIAM R. DUDLEY,
Cryptogamic Botanist.

REPORT OF THE ENTOMOLOGIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR:

In compliance with your request I beg leave to submit the following report of the work of this division during the year just closed.

The year has been a very successful one; certain experiments have been brought to a satisfactory conclusion; and others recently started, promise to give important results.

The study of *Cephus pygmaeus*, a saw-fly borer in wheat, has been nearly completed, and a Bulletin, (No. XI), has been published giving the results obtained. In this Bulletin the complete life-history of the species is described in detail, and practical conclusions are drawn from the results obtained. Further observations are desirable in order to determine in what other plants the insects can live. It is my purpose to make these observations during the coming summer.

The study of the Clematis disease is well advanced; and a preliminary report on it was presented to the Western New York Horticultural Society at their recent meeting, as it was from members of this society that the diseased plants were received. I have definitely determined that the cause of the disease is a Nematode worm belong to the family *Anguillulidae*, as suggested in my report of last year. The species is *Heterodera radicicola*. This worm has attracted much attention in various parts of the country during the past year, as it has been found to infest a great variety of plants, and to do much injury. Much material including a full account of the life-history of the pest, with figures of its different stages, is at hand; and I purpose to submit a Bulletin upon it at an early date. These studies have been carried on in the Insectary. I wish now to conduct a series of experiments in the field for the purpose of determining the best method of combatting this pest. Should there be funds available for this purpose, I recom-

mend the preparation in the spring of a series of plats, separated by walls through which the worms cannot pass, for these experiments. As this worm infests to a serious extent nearly all of our common garden vegetables, it will be an easy matter to obtain material for experimentation.

The work upon wire-worms is still in progress. Several species have been reared to the adult state, and experiments have been tried to determine the value of the growing of buckwheat, and of mustard, on infested lands in order to starve the worms. I am not yet ready to announce any definite results; but our experiments seem now to indicate that the importance of this remedy has been greatly over-estimated.

Much attention is being given, especially by several of the agricultural students, to the study of greenhouse pests. One of these pests, which occurred in great numbers both in the Insectary and in the plant-houses of the Horticultural Department, is a species which has not previously been mentioned as occurring in this country, although it is a well known European pest. It is in its early stages a scale-like insect, infesting the lower surface of the leaves of various plants. In the adult state it is a minute fly, which is very conspicuous on account of a white, mealy powder with which the body and wings are covered; it is known to entomologists as *Aleyrodes vaporiorum*. Two of the agricultural students are making studies in the Insectary upon mealy bugs, upon which they are to write their theses. I confidently expect that conclusions will be reached by them which will be of practical importance.

The preparations for the study of hop insects are now completed; as our hop-yard is well established, and the hop Aphis appeared in it last fall.

The experience of the past year has realized our expectations in regard to the value of an Insectary. This building has proved indispensable to our work; and the importance of such a building is being appreciated elsewhere, for similar structures have been erected at two other Stations.

I am your obedient servant,

J. H. COMSTOCK,

Entomologist.

REPORT OF THE AGRICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR:

The work of this division of the Experiment Station has been, in the main, that outlined in the report made to you one year ago. During the year investigations have been completed and published as follows:

In Bulletin No. V.—The Production of Lean Meat in Mature Animals.—The Effect of Heating Milk on the Quantity and Quality of Butter.

In Bulletin No. VIII.—The Effect of Nitrogenous and Carbonaceous Foods on Fattening Lambs.

In Bulletin No. XIII.—The Deterioration of Farm Yard Manures by Leaching and Fermentation.—The Effect of a Grain Ration for Cows at Pasture.

Beside the above, the work of which has nearly all been done within the calendar year, investigations in the following lines have been made, and are now either in process of or awaiting publication:

A comparative field and chemical test of all of the varieties of field corn recommended as valuable for ensilage purposes.

A determination of the loss of weight and dry matter in the process of ensilaging green fodder.

A repetition of the experiments of last year in regard to the changes in the composition of the corn plant at different stages of growth.

Another series of experiments on the production of lean meat in mature animals.

The main lines of investigation now under way are:

The effect of different nitrogenous foods on meat production (lambs are the subject of experiment.)

The effect of nitrogenous and carbonaceous foods on development and fecundity (swine are the subject of experiment.)

A comparative test of different breeds and crosses of sheep in the production of winter lambs.

A continuation of the work in the field experiments with fertilizers.

Some investigations in the manufacture and ripening of cheese.

For the future, beside a repetition of numerous of our investigations that we feel need further elucidation, experiments have been outlined in soil culture, and in the relations of the clover plant to soil exhaustion.

The work of the division has progressed during the year smoothly and, in the main, successfully. The details of the experiments in the fields and barns have been almost entirely in the hands of Mr. Ed Tarbell, Assistant in Agriculture, to whom credit is due for careful and faithful work.

HENRY H. WING,

REPORT OF THE HORTICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR:

The past year has been a prosperous one for the Horticultural Division. The area set aside for orchards and gardens has been placed under culture, and permanent improvements have been made upon the greater part of it. Plantations have been made of all fruits suited to the climate, in considerable variety. The primary object in the setting of the fruit is the determination of certain points in culture and treatment, rather than the mere testing of varieties. An orchard of pears and plums has been set upon land which has never received stable manure, and it is designed to maintain it solely upon commercial fertilizers and methods of cropping.

The origination of varieties of fruits and vegetables is designed as the leading perennial experiment of the department. Already great quantities of seeds of fruits have been sown. The Ignotum tomato, a superior variety, which originated with the writer in 1887, has been further selected and tested, and this year it has been put upon the market. Endeavors towards the origination of varieties demand the study of all features of the variation of plants under culture. Extensive labors have been inaugurated in hybridization and crossing, particularly in the *Cucurbitaceæ*, the pumpkin and melon family. Hybridization is little understood in plants of this family, although much discussed. So extensive have been the studies among these plants during the past year, that several acres will be required the coming season upon which to grow the crosses and selections.

Large and satisfactory tests have been made upon tomatoes and egg-plants; and the leading results of the studies of tomatoes have been published in a bulletin. Extensive tests have also been made upon the influence of many fertilizers in hastening maturity of plants. These, and several other experiments which we have in hand, must run through several years before definite reports can be made.

Three bulletins have been published by the division: "On the Influences of Certain Conditions upon the Sprouting of Seeds," "Windbreaks in their Relation to Fruit Growing," and "Tomatoes."

Some good forcing-houses have been completed, and various experiments are now proceeding in them. One house, 20×30 feet, is now carrying an experimental crop of tomatoes; another of the same size contains chiefly cucumbers and melons, and a small lean-to is being used for radish tests. The most conspicuous experiment under glass, however, is one now in progress to determine the influence of the electric light upon the growth of plants. A house, 20×60 feet, has been divided, and one part is lighted all night by an arc-light, while the other is left in darkness. The areas are large enough to allow of several hundred plants being grown in each compartment, and valuable results are anticipated. This is probably the largest and completest experiment of the kind yet projected.

Many minor yet valuable experiments are always in progress, and it is gratifying to know that records of them can be made in the closing bulletin of each year. It is now desirable that some provision be made for the publication of such extended and technical papers as must result from prolonged studies in particular directions.

Respectfully submitted,

L. H. BAILEY,
Horticulturist.

APPENDIX I.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

V.

APRIL, 1889.

I. On the Production of Lean Meat in Mature Animals.

II. Does Heating Milk Affect the Quality or Quantity of Butter.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1889.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 18 A, Morrill Hall.

Persons who desire this Bulletin will be supplied on addressing

CORNELL UNIVERSITY EXPERIMENT STATION,

Ithaca, N. Y.

ON THE DETERMINATION OF HYGROSCOPIC WATER IN AIR-DRIED FODDERS.

The determination of moisture is one of the most important operations in fodder analysis, but as yet little attention has been given to fixing a standard method, based on the results of actual experiments. The amount of dry matter, which serves as a basis for the calculation of the amount of ether-extract, nitrogen, ash, crude fibre, and nitrogen-free extract being directly dependent on the amount of moisture, any inaccuracy in this determination affects the amount of the several other constituents found.

Dr. Jenkins of the Connecticut Experiment Station, in his report to the Committee on Cattle Foods of the Association of Official Agricultural Chemists, published in Bulletin No. 19, Division of Chemistry, Department of Agriculture, gave results obtained (1) by drying at 100° in an air bath; (2) by drying in a current of hydrogen at the same temperature; and (3) by drying in hydrogen at 110°–115°.

He shows that in three samples of fodder the amount of moisture found is larger when the current of hydrogen is employed—also that a temperature of 110°–115° causes a greater loss than takes place at 100°. In a similar report, as yet unpublished, he obtains somewhat similar results.

The following experiments were undertaken to throw some further light on this important matter.

Three samples of fodder, viz.: hay, wheat bran, and cotton-seed meal, were pulverized as for a complete analysis. Ten different methods of drying were tested, described briefly as follows:

A.—Drying in watch-glasses in a boiling water bath, temperature quite constant viz., 97°.

B.—Drying in watch-glasses in an air bath. The temperature did not vary one degree either way from 100°.

C.—Similar to B, the temperature, however, being raised to 110°–115°.

D.—The substance was placed in a tube through which a current of dry air was passed, the tube being heated in the water bath at 97°.

E.—The substance was treated, as in D, with the temperature at 100°

centage of sprouting. Causes which determine the viability and vigor of seeds are either congenital, or due to the conditions of harvesting or storing. The expression or measure of this viability and vigor is again determined by the conditions of germination. In the present investigation, with the exception of studies of the relations of weight and color to sprouting, only the conditions of germination have received attention. Seeds can be so readily selected in reference to weight and color, that it was thought advisable to study these phases of the subject in connection with conditions which may be fully controlled by the operator.

The importance of seed-testing is obvious, yet its value is apparently commonly misapprehended. Its primary value is the determination of the vitality of a given sample. This testing, except in rare instances, should be conducted by the grower himself. The proper work for the experiment station is that of determining the best methods and conditions of testing each species and variety; in other words, it seems that the sphere of the stations is to discover and announce laws and rules, rather than to perform the petty tests for the multitude. Merely testing seeds for the purpose of determining how many will grow, is surely not experiment, and the publication of disconnected tests seems to be entirely unprofitable. The endeavor to determine the relative merits and honesty of seedsmen, by means of testing their seeds, is the merest folly.

There appears to be no necessity for seed-control stations in this country, certainly not for such seeds as fall to the hands of the horticulturist. The control stations of the Old World have sufficiently exposed the tricks of seedsmen, and have rendered open dishonesty unprofitable. There is now such sharp competition in the seed business that seedsmen themselves must exercise every caution in order to demand trade. Improved methods and apparatus for harvesting and cleaning are giving us clean samples. The greatest risk in the purchase of seeds is the possibility that inferior strains or varieties may be procured, but this is a risk which the control station could not assume to govern, inasmuch as the substitution becomes apparent only when the crop is grown. The experiment stations may be expected to influence sufficient control in the seed business, as occasion shall require.

The tests enumerated in the following pages have been conducted with the greatest care. Unless otherwise recorded, they have been made in a steam-heated forcing-house. As a rule, they

have been made in earth in shallow earthen seed-pans. These pans are exceedingly convenient, and they afford good drainage. In some cases, lily-pans have been used, but they differ from the seed-pans only in their circular outline and somewhat greater depth. Illustrations of seed-pans may be seen in Figs. 3 to 7. For sowing seeds at uniform depths, two devices have been used. The simpler of these, (Fig. 1), is nothing more than a block of half-inch stuff, two inches wide, of the required length, upon which is nailed a cleat equal in thickness to the depth of sowing. The cleat is pressed into the soil evenly, and the seeds are dropped into the furrow it makes. The other device, (Fig. 2). may be called the Tracy planter.* It consists of two strips of heavy tin plate nearly three inches wide, hung upon two wire pivots or hinges some two inches long. At their upper edges and equidistant from either end, the plates are joined by a firm spiral spring, which serves to throw the upper edges apart, and to cause the lower edges to join. This trough is now filled with the required number of seeds, and is then inserted into the earth to a given depth, when the fingers push inward on the spring and the trough opens and delivers the seeds.

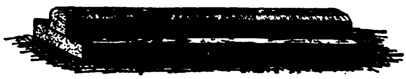

FIG. 1.

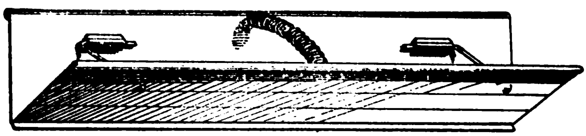

FIG. 2.

In this paper, the following points are discussed :

I. Influences of temperature upon sprouting.
II. Influences of varying amounts of water.
III. Influences of soaking seeds before sowing.
IV. Influences of soil.
V. Influences of light.
VI. Influences of weight of seed.
VII. Influences of color of seed.
VIII. Influences of latitude.
IX. Duplicate tests.
X. Comparisons of tests and actual plantings.
XI. Impurities in samples.
General Summary.

* Mr. W. W. Tracy, of the firm of D. M. Ferry & Co., gave the writer the plan for this implement.

I. INFLUENCES OF CONSTANT AND VARIABLE TEMPERATURES.

The tests here enumerated were made in an incubator of which the temperature was controlled by a galvanic current communicating with clock-work, and in a steam-heated forcing-house. In the incubator the temperature rarely varied three degrees, while the position of the seed-table in the forcing-house was such that variation sometimes amounted to sixty-five degrees. In some cases, duplicate tests were made in an out-door cellar which was used for the storing of nursery stock.

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1. Bean, *Green Flageolet.*—Department of Agriculture.

No. 1, 100 beans in folds of cloth in seed-pan, in incubator.
No. 2, same in forcing-house.

SOWN MAR. 29.

SAMPLES.	DAILY SPROUTINGS. APRIL.					Total.	Per cent.	Average temperature during test.	Extremes of temperature.
	2	3	4	5	6				
No. 1 Incubator,	**56**	18	15	2		91	**91**	75°	73°, 76°
No. 2 Forcing-house,	**30**	38	11	2	1	82	**82**	76°	118°, 53°

Epitome.—Under constant temperature sprouting was much more rapid, and the total per cent. was also greater, although the mean temperature in the other test was somewhat higher.

2. Bean, *Green Flageolet.*—Department of Agriculture.

No. 1, 100 beans on sand and covered with cloth in seed-pan, in the incubator.
No. 2, same in forcing-house.

SOWN MAR. 29.

SAMPLES.	DAILY SPROUTINGS. APRIL.					Total.	Per cent.	Average temperature during test.	Extremes of temperature.
	1	2	3	4	5				
No. 1 Incubator,	**1**	**31**	41	19		92	**92**	75°	73°, 76°
No. 2 Forcing-house,	**3**	**22**	51	18	1	95	**95**	76°	118°, 53°

Epitome.—Sprouting was rather more rapid under constant temperature, although total per cent. of sprouting was slightly higher under varying temperatures. It is probable that this method of sowing is unreliable, as the repetition of this test appears to indicate:

3. **Bean,** *Green Flageolet.*—Department of Agriculture.

No. 1, 50 beans on sand and covered with cloth in seed-pan, in incubator.
No. 2, same, in forcing-house.

SOWN APR. 15.

SAMPLES.	DAILY SPROUTINGS. APRIL. 17	18	19	20	21	Total.	Per cent.	Average temperature during test.	Extremes of temperature.
No. 1 Incubator,		2	36		1*	39	78	75°	73°, 76°
No. 2 Forcing-house,	3	26	11	1	2	43	86	78°	101°, 57°

* The beans decayed badly.

Epitome.—Better results, both in rapidity and per cent. of sprouting, occurred under varying temperatures. In constant temperature the beans decayed badly, owing, perhaps, to the manner in which they were sown; the sprouting was slow, evidently from the same reason, as the beans were probably too moist in the confined atmosphere of the incubator.

4. **Bean,** *Green Flageolet.*—Department of Agriculture.

No. 1, 100 beans in folds of cloth in seed-pans, in incubator.
No. 2, same in forcing-house.

SOWN APR. 15.

SAMPLES.	DAILY SPROUTINGS. APRIL. 17	18	19	20	Total.	Per cent.	Average temperature during test.	Extremes of temperature.
No. 1, Incubator,	25	63	5	3	96	96	75°	73°, 76°
No. 2, Forcing-house,	8	50	32	3	93	93	78°	101°, 57°

Epitome.—Much greater rapidity of sprouting occurred under constant temperature, although the mean temperature was higher in the other case. The total per cent. of sprouting was also slightly higher under constant temperature.

5. **Bean,** *Green Flageolet.*—Department of Agriculture.

No. 1, 50 seeds, green-colored, between cloth, in a seed-pan, in incubator,
No. 2, same in forcing-house.

SOWN APR. 23.

SAMPLES.	DAILY SPROUTINGS. APRIL. 25	26	27	28	Total.	Per cent.	Average temperature during test.	Extremes of temperature.
No. 1, Incubator,	13	18	12	2	45	90	74°	72°, 75°
No. 2, Forcing-house,	1*	22	7	1	31	62	73.6°	90°, 60°

* No. 2 was not so uniformly moist during the first day as No. 1.

Epitome.—Sprouting was more rapid under constant temperature, and the total amount was nearly 30 per cent. higher.

6. Bean, *Green Flageolet*.—Dreer.

No. 1, 100 white beans on sand in 5-inch seed-pan, in incubator.
No. 2, same, in forcing-house. SOWN MAY 6.

SAMPLES.	DAILY SPROUTINGS. MAY.				Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	8	9	10	11				
No. 1, Incubator,	**19**	**66**	7		92	**92**	74°	72°, 75°
No. 2, Forcing-house,	**17**	**33**	23	8	81	**81**	76°	105°, 46°

Epitome.—Sprouting was much more rapid under the constant temperature, although the mean temperature in the other test was 2° higher. The total sprouting was also greater under constant temperature.

7. Bean, *Green Flageolet*.—Dreer.

No. 1, 100 green-colored beans on sand in 5-inch seed-pan, in incubator.
No. 2, same in forcing-house. SOWN MAY 6.

SAMPLES.	DAILY SPROUTINGS. MAY.					Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	8	9	10	11	12				
No. 1, Incubator,	**4**	**78**	16			98	**98**	74°	72°, 75°
No. 2, Forcing house,	**5**	**14**	30	36	11	96	**96**	76°	105°, 46°

Epitome.—Sprouting was much more rapid under constant temperature, although the mean temperature in the other test was 2° higher. The total amount of sprouting was slightly higher under constant temperature.

8. Pea, *White Garden Marrowfat*.—Thorburn.

30 Peas in each of six 5-inch seed-pans, ½ inch deep in sand.
Nos. 1 and 2, placed in incubator.
Nos. 3 and 4, in forcing-house.
Nos. 5 and 6, in cellar. SOWN APRIL 29.

SAMPLES.	DAILY SPROUTINGS. MAY.											Total.	Per Cent.	Average Temperature during test.	Extremes of Temperature.
	3	4	5	6	7	8	9	10	11	12	13				
No. 1 Incubator,	**9**											*		74°	72°, 75°
No. 2 Incubator,	**29**														
No. 3 Forcing-house,		**3**	16	3	2	1						25	**83**	74°	105°, 46°
No. 4 Forcing house,		**3**	16	5	4	1	1					30	**100**		
No. 5 Cellar,								**10**	14	2		26	**86⅔**	53° (For first 7 days 46°.)	83°, 43°
No. 6 Cellar,								**12**	6	1	1	20	**66⅔**		

*Owing to a defect in the incubator, the temperature ran up to 90° on May 4. At this time the remainder of the seeds (91) had sprouted, but this test was discontinued, and this part of the experiment was repeated with the following results:

SOWN MAY 4.

SAMPLES.	DAILY SPROUTINGS. MAY. 6th.	7th.	8th.	9th.	Total.	Per Cent.	TEMPERATURE.
No. 1 Incubator,		**5**	19	2	26	**86⅔**	On the fifth day the temperature again ran too high and the test was discontinued.
No. 2 Incubator,	**1**	**20**	6		27	**90**	

Epitome.—The rapidity of sprouting was much greatest under constant temperature, while in the cellar, with a mean temperature 21° lower, the seeds were about nine days behind. Percentages were rather better under variable high temperatures, and lowest under variable low temperatures.

9. Radish, *Half-Long Early Scarlet.*—Vilmorin.

50 seeds in each of 6 5-inch seed-pans, ¼ inch deep in sand.
Nos. 1 and 2, placed in incubator.
Nos. 3 and 4, in forcing-house.
Nos. 5 and 6, in cellar.

SOWN APR. 26.

SAMPLES.	DAILY SPROUTINGS. APR. 28	29	30	MAY. 1	2	3	4	5	6	7	8	9	10	11	12	13	Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
No. 1, Incubator,		**24**	6	8		3											41	**82**	74°	72°, 75°
No. 2, Incubator,		**21**	3	1	2												27	**54**		
No. 3, Forcing hse.		**22**	3	2	1	1											29	**58**	71°	82°, 63°
No. 4, Forcing-hse.	**3**	**24**	2	3	2	2											36	**72**		
No. 5, Cellar,								**3**	**5**	10	10	2	3	1		1	35	**70**	54°*	83°, 43°
No. 6, Cellar,									**7**	17	8	4	2	2			40	**80**		

* Average for first nine days, 48½°.

Epitome.—There is no marked difference in rapidity of sprouting, between samples in constant temperature and those in varying temperatures with a high mean, but there is great difference between these two sets of samples and those under varying temperatures with a mean 17° lower. Three days after sowing, 45 seeds had sprouted in the incubator, and 49 in the forcing-house, while it was not until the eleventh day that 42 seeds had sprouted in the cellar. Yet the total sprouting was greatest in the cellar by 7 and 10 per cent.

10. Turnip, *Red Top Strap Leaf.*—Thorburn.

50 seeds of each number, ¼ inch deep in sand, in 5-inch seed-pans.
Nos. 1 and 2, placed in incubator.
Nos. 3 and 4, in forcing-house.
Nos. 5 and 6, in cellar.

SOWN APR. 24.

SAMPLES.	DAILY SPROUTINGS.														Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	APR.					MAY												
	26	27	28	29	30	1	2	3	4	5	6	7	8	10				
No. 1, Incubator,	**8**	**27**				1	1	1							38	**76**	74°	72°, 75°
No. 2, Incubator,	**13**	**22**	1		1	1	1	1							39	**78**		
No. 3. Forcing-house,	**1**	**27**	8	1	2	1	2	1							43	**86**	74½°	105°, 56°
No. 4, Forcing-house,		**16**	21	3	2										42	**84**		
No. 5, Cellar,										**3**	16	17		1	37	**74**	51.8°	83°, 43°
No. 6, Cellar,									**9**	**8**	14	7	1		39	**78**		

Epitome.—Sprouting was decidedly most rapid under constant temperatures, and it was fully nine days behind in the cellar where the mean temperature was about 22° lower. The rapidity was also greater in samples under constant temperatures than in those under equally high varying temperatures. The greatest per cent. of sprouting occurred under high variable temperatures, while there was scarcely any difference between percentages under constant and low variable temperatures.

11. Turnip, *Red Top Strap Leaf*.—Thorburn.

50 seeds in each of four 5-inch seed-pans, ¼ inch deep in sand.
Nos. 1 and 2, placed in incubator.
Nos. 3 and 4, in forcing house.

SOWN MAY 4.

SAMPLES.	DAILY SPROUTINGS.			Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	MAY						
	7	8	9*				
No. 1, Incubator,	**38**	2		40	**80**	74°	72°, 75°
No. 2, Incubator,	**34**	3	1	38	**76**		
No. 3, Forcing-house,	**41**	1		42	**84**	77°	101°, 56°
No. 4, Forcing-house.	**44**	3	1	48	**96**		

* At this time trouble with the incubator caused the work to be concluded.

Epitome.—Sprouting was somewhat more rapid under varying temperatures, while the total amount of sprouting at the end of five days was 12 per cent greater under varying temperatures.

12. Onion, *Giant Yellow Globe Rocca*.—Department of Agriculture.

No. 1, 50 seeds, soaked in water 10 hours and sown ¼ inch deep in sand in 5-inch seed-pan, in incubator.
No. 2, same, in forcing-house.

SOWN MAR. 29.

SAMPLES.	DAILY SPROUTINGS. APRIL.							Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	3	4	5	6	7	9	10				
No. 1, Incubator,	**7**	**17**	11	3	2	3	1	44	**88**	74°	72°, 75°
No. 2, Forcing-house,		**6**	13	15	9	2		45	**90**	76°	118°, 53°

Epitome.—Under constant temperature, rapidity of sprouting was much greater, while per cent of sprouting was essentially the same in both tests.

13. **Onion,** *Giant Yellow Globe Rocca.*—Department of Agriculture.

No. 1, 50 seeds soaked in water 20 hours and sown ¼ inch deep in sand in 5-inch seed-pan, in incubator.

No. 2, same, in forcing-house.

SOWN MAR. 29.

SAMPLES.	DAILY SPROUTINGS. APRIL.									Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	3	4	5	6	7	8	9	10	11				
No. 1, Incubator,	**9**	**8**	6	3	2	1	2	1	1	33	**66**	74°	72°, 75°
No. 2, Forcing-house,		**3**	14	8	6	2	1	1	2	37	**74**	76°	118°, 53°

Epitome.—Under constant temperature, sprouting was more rapid, but the total per cent. was slightly less.

14. **Onion,** *Giant Yellow Globe Rocca.*—Department of Agriculture.

No. 1, 50 seeds soaked 30 hours in water and sown ¼ inch deep in sand, in 5-inch seed-pan, in incubator.

No. 2, same, in forcing-house.

SOWN MAR 29.

SAMPLES.	DAILY SPROUTINGS. APRIL.							Total.	Per cent.	Average temperature during test.	Extremes of temperature
	4	5	6	7	8	9	11				
No. 1, Incubator,	**11**	**14**	5	4	3		2	39	**78**	74°	72°, 75°
No. 2, Forcing-house,	**7**	**18**	11	6		1	1	44	**88**	76°	118°, 53°

Epitome.—Under constant temperature, sprouting was a trifle more rapid, although, at the end of the second day, the same number of seeds had sprouted in each test. The per cent. of sprouting was greater under varying temperatures.

15. Onion, *Giant Yellow Globe Rocca.*—Department of Agriculture.

50 seeds of each number sown ¼ inch deep in sand, in 5-inch seed-pans.
No. 1, placed in incubator.
No, 2, in forcing-house.
No. 3, in cellar.

SOWN APR. 23

SAMPLES.	DAILY SPROUTINGS.										Total.	Per Cent.	Average temperature during test.	Extremes of temperature.
	APR.			MAY.										
	28	29	30	1	2	3	10	11	12	13				
No. 1, Incubator,	**6**	**23**	15	2	1						47	**94**	74°	72°, 95°
No. 2, Forcing-house,	**7**	**25**	5	2	2	1					42	**84**	72°	90°, 60°
No. 3, Cellar,							**25**	11	1	3	40	**80**	†53°	*83°, 43°

* The door was open and the sun shone in in the afternoon.

† Average for the first thirteen days, 49°. There was no sign of germination in the cellar until circumstances demanded the admission of air and sunlight for the good of other things in the cellar.

Epitome.—There were no important differences in rapidity of sprouting between the sample under constant temperature and that under high variable temperatures, but the seeds in the cellar, in which the mean temperature was 19° and 21° lower than in the other cases, were about twelve days behind. Percentages of sprouting decreased with the decrease of the mean temperature, though not proportionately.

CONCLUSIONS From the Foregoing Tests, upon the Influences of Constant and Variable Temperatures upon the Sprouting of Seeds.

1. Different results are obtained from the same sample of seeds under different variations of. temperature, of which the daily mean is essentially the same.

2. Sprouting takes place more quickly under essentially constant temperature of about 74° than under a temperature ordinarily variable, which gives about the same mean.

3. Rapidity of sprouting is particularly marked in beans and peas.

4. As the mean temperature becomes lower, rapidity of sprouting becomes slower.

5. Greater rapidity of sprouting does not appear to be correlated with greater per cent. of total sprouting.

6. Constant temperature, of the degree here mentioned, does not appear to give greater percentages of sprouting; at least, the variation in this respect between the constant and variable temperatures is no greater than that which is usually obtained from tests conducted under identical conditions. In the seven tests with beans, however, there is an average gain of 5 per cent. in favor of those under constant temperature.

II. INFLUENCES OF DIFFERENT QUANTITIES OF WATER UPON SPROUTING.

Mr. W. W. Tracy, of Detroit, well known as an expert in the handling and testing of seeds, once said to me that he rarely obtained the same results from different tests of the same sample, if made in houses under the care of different men. He attributed this variation mostly to the various amounts of water habitually used by the different men. Acting upon this suggestion, a number of very careful tests have been made in weighing the amounts of water used. The results have been the most marked of any which have ever come under my notice in the testing of seeds.

The tests were all made side by side in a forcing-house, unless otherwise recorded, in earthen pans. The soil, with one exception, was a good quality of light potting earth, containing a good admixture of field sand. Although the pans were very shallow, extra drainage was given by the use of broken pots. The samples which received the most water were rarely wet enough to drip; in fact, they had no more water than is given in many houses. The pans sparingly watered were drier than they would be kept in most houses. The 8-inch round lily-pans are 4½ in. deep. The 10-inch seed-pans are 2½ in. deep, and the 12-inch pans 3 in. deep.

16. Tomato, *Green Gage*.—Thorburn.

100 seeds in 8-inch round lily pans, sown ¾ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 7, 6 P. M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES.						SPROUTINGS.						
	MAY.					Total.	MAY.					Total.	Per cent.
	7th 6 P. M.	8th 5 P. M.	9th 5 P. M.	11th 6 P. M.	14th 6 P. M.		13th	14th	15th	16th	17th		
No. 1, Profusely watered,	16	9	7	6	6	44 oz		13	2	13	19	47	47
No. 2, Sparingly watered,	7		3	3	6	19 oz	12	18	8	21	5	64	64

Epitome.—Sprouting was much more rapid in the seeds which were sparingly watered, and the total per cent. of sprouting was 17 per cent. greater in the same test.

Two other pans were prepared in the same manner but were subjected to a lower temperature for two consecutive nights to imitate the conditions of testing in an ordinary kitchen. The results are recorded in the next table.

17. Tomato, *Green Gage*.—Thorburn. (Compare with No. 16.)

100 seeds in 8-inch round lily-pans, sown ¾ inch deep, and placed in a cellar, with a temperature at 45°, for the first two nights after sowing. The pans were at other times set in the forcing-house alongside those of No. 16.

No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 7, 6 P. M.

SAMPLES.	AMOUNTS OF WATER IN OUNCES.						SPROUTINGS.					
	MAY.						MAY				Total.	Per Cent.
	7th 6 P. M.	8th 5 P. M.	9th 5 P. M.	11th 6 P. M.	14th 6 P. M.	To-tal.	14th	15th	16th	17th		
No. 1, Profusely watered,	16	9	7	6	6	44 oz	2	11	20	14	47	47
No. 2, Sparingly watered,	7	3	3	6		19 oz	12	56	6		74	74

Epitome.—Sprouting was very much quicker in the sample which was sparingly watered, and the per cent. of sprouting was 27 per cent. greater. The low temperature of the cellar delayed sprouting about twenty-four hours, or essentially the length of time the seeds remained in the cellar.

18. Cucumber, *Nichol's Medium Green.*—Department of Agriculture.

50 seeds in 8-inch round lily pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 8, 6 P. M.

SAMPLES.	AMOUNTS OF WATER IN OUNCES. MAY.					SPROUTINGS. MAY.					
	8th 6 P. M.	9th 5 P. M.	11th 6 P. M.	14th 6 P. M.	Total.	13th	14th	15th	16th	Total	Per Cent.
No. 1, Profusely watered,	16	7	6	10	39 oz	2	26	5	5	38	76
No. 2, Sparingly watered,	7	3	3	5	18 oz	28	4	1		33	66

Epitome.—Sprouting was very much more rapid in the sample which was sparingly watered, although the total amount of sprouting was 10 per cent. less. The lower percentage appeared to be due to the fact that near the close of the test the pan became too dry.

Two similar pans were prepared and set in a cellar for two nights, after the manner of the preceding experiment. The results are as follows :

19. Cucumber, *Nichol's Medium Green.*—Department of Agriculture. (Compare with No. 18.)

50 seeds in 8-inch round lily-pans, sown ½ inch deep, and placed in a cellar, with a temperature of 45°, for the two nights following sowing. At other times the pans were placed in the forcing-house with those of No. 18.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 8, 6 P. M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES. MAY.						SPROUTINGS. MAY.				
	8th 6 P. M.	9th 5 P. M.	10th 5 P. M.	11th 6 P. M.	14th 6 P. M.	Total.	14th	15th	16th	Total.	Per cent.
No. 1, Profusely watered,	16	7		6	10	39 oz	18	7	11	36	72
No. 2, Sparingly watered,	7	3	3	3	5	21 oz	30	5	1	36	72

Epitome.—Sprouting was more rapid in the drier pan, while per cent. of sprouting was the same in each. The low temperature of the cellar delayed sprouting about twenty-four hours, or essentially the length of time the seeds were left in the cellar.

20. Lettuce, *Boston Market.*—Department of Agriculture.

100 seeds in 12-inch seed-pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered, SOWN MAY 7, 5 P. M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES.							SPROUTINGS.						
	MAY.						Total.	MAY.					Total.	Per Cent.
	7th 5 P. M.	8th 5 P. M.	9th 5 P. M.	10th 5 P. M.	11th 6 P. M.	14th 6 P. M.		11th	13th	14th	15th	16th		
No. 1, Profusely watered,	27	10	20		6	6	69 oz.	**29**	**10**	5	1	2	47	**47**
No. 2, Sparingly watered,	8	5	7	5	3	6	34 oz.	**34**	**17**	5	8	13	77	**77**

Epitome.—Sprouting was considerably more rapid in the drier pan, while total sprouting was 30 per cent. greater.

21. Carrot, *Vermont Butter.*—Hoskins. (Fig. 3.)

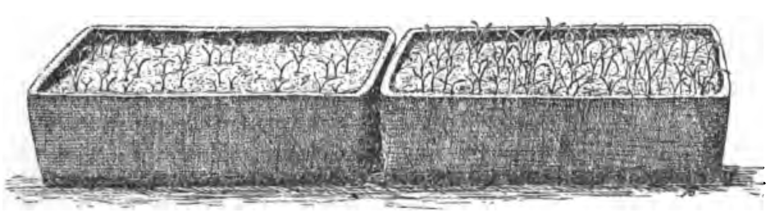
100 carpels, in 10-inch seed-pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered. SOWN MAY 4, 6 P. M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES.											
	MAY.											Total.
	4th 6 p.m.	6th 10 a.m.	6th 2 p.m.	6th 6 p.m.	7th noon	7th 5 p.m.	8th 5 p.m.	9th 5 p.m.	10th 5 p.m.	11th 6 p.m.	14th 6 p.m.	
No. 1, Profusely watered,	16	9		4	9		10	7			6	61 oz
No. 2, Sparingly watered,	4		2		3	2	5	5	3	3	4	31 oz

SAMPLES.	SPROUTINGS.							Total.	Per Cent.
	MAY.								
	10	11	13	14	15	16	17		
No. 1, Profusely watered,		**1**	**3**	8		14	9	35	**35**
No. 2, Sparingly watered,	**17**	**38**	**19**	7	1			82	**82**

Epitome.—Sprouting was remarkably more rapid in the drier pan, and the per cent. of sprouting was also very much greater, amounting to 47 per cent.

Figure 3, from a photograph, represents this test at its conclusion.



Wet Pan. FIG. 3.—Table 21. *Dry Pan.*

22. Carrot, *Early Forcing.*—Thorburn.

100 carpels, in 8-inch round lily pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 6, 3 P. M.

SAMPLES.	Amounts of Water, in Ounces.									Sproutings.							
	May.									May.							
	6th 3 p. m.	6th 6 p. m.	7th noon.	8th 5 p. m.	9th 5 p. m.	10th 5 p. m.	11th 6 p. m.	14th 6 p. m.	Total.	13	14	15	16	17	18	Total.	Per Cent.
No. 1, Profusely watered,	16	4	9	9	7		6	3	54 oz.		**1**	**5**	9	6	11	32	**32**
No, 2, Sparingly watered,	4			3	3	3	3	3	19 oz.	**9**	**7**	**28**	24	4	2	74	**74**

Epitome.—Sprouting was remarkably more rapid in the drier pan, and the total sprouting at the end of the twelfth day was 42 per cent greater.

23. Celery, *White Plume.*—Cornish.

100 carpels, in 8-inch round lily-pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 6, 3 P. M.

SAMPLES.	Amounts of Water, in Ounces.																		
	May—June.																		
	6th, 3 p. m.	6th, 6 p. m.	7th, 12 m.	8th, 5 p. m.	9th, 5 p. m.	10th, 5 p. m.	11th, 6 p. m.	14th, 6 p. m.	16th, 6 p. m.	17th, 6 p. m.	18th, 6 p. m.	22d, 6 p. m.	25th, 6 p. m.	28th, 6 p. m.	30th, 6.30 p. m.	2d, 6 p. m.	6th, 4 p. m.	10th, 6 p. m.	Total.
No. 1, Profusely watered,	16	4	9	9	7		6	3	3	7	7	3	4	4	4	4	6	4	100
No. 2, Sparingly watered,	4			3	3	3	3	3	3	4	4	3	4	4	4	4	6	4	59

SAMPLES.	Sproutings.														
	May—June.														
	20	21	24	25	27	28	30	1	4	6	8	10	14	Total.	Per Ct.
No. 1, Profusely watered,	**1**				**2**			1	1	2	3	9	3	22	**22**
No. 2, Sparingly watered,	**4**	**1**	**2**	**2**	**3**	**12**	7	2	16	3	4	4		60	**60**

Epitome.—Sprouting was much more rapid and regular in the drier pan, and the per cent. of sprouting was nearly three times greater.

24. Turnip, *Early Six Weeks.*—Department of Agriculture.

100 seeds in 12-inch seed-pans, sown ½ inch deep in silver sand.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 7, 5 P. M

SAMPLES.	Amounts of Water in Ounces.						Sproutings.					
	MAY.						MAY.					
	7th 5 P.M.	8th 5 P.M.	9th 5 P. M.	11th 6 P. M.	14th 6 P. M.	Total.	10th.	11th.	13th.	14th.	15th.	Total.
No. 1, Profusely wat'red,	30	20	20	6	5	81 oz		**10**	11	2		23*
No. 2, Sparingly wat'red,	9	5	7	3	12	36 oz	**7**	**15**	8		2	32

*Both pans accidently became very dry on May 15, and the test was concluded.

Epitome.—There was a very great gain in rapidity of sprouting in the pan sparingly watered, and a corresponding gain in percentage, at the premature conclusion of the test.

25. Pepper, *Golden Dawn.*—Henderson.

100 seeds, in 8-inch round lily-pans, sown ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 6, 6 P. M.

SAMPLES.	Amounts of Water, in Ounces.																	Total.
	MAY—JUNE.																	
	6th, 6 p. m.	7th, 12 m.	8th, 5 p. m.	9th, 5 p. m.	10th, 5 p. m.	11th, 6 p. m.	13th, 4 p. m.	14th, 6 p. m.	16th, 6 p. m.	18th, 6 p. m.	20th, 6 p. m.	25th, 6 p. m.	28th, 6 p. m.	30th, 6.30 p. m.	2nd, 6 p. m.	6th, 4 p. m.	10th, 6 p. m.	
No. 1, Profusely watered,	16	9	9	7		3	7	3	7	7	5	4	4	4	4	6	4	99 oz.
No. 1, Sparingly watered,	4		3	3	3	6	3	3	3	4	3	4	4	4	4	6	4	61 oz.

SAMPLES.	Sproutings.											Total.	Per cent.
	MAY—JUNE.												
	18	20	21	22	23	25	27	28	1	6	10		
No. 1, Profusely watered,		**3**	10	4	6	6	5	7	10	1	1	53	**53**
No. 2, Sparingly watered,	**28**	**23**	4	1	1	1	1		2			61	**61**

Epitome.—Sprouting was most remarkably more rapid in the drier pan, although the total sprouting was only 8 per cent. greater.

26. Lima Bean, *Large White.*—Dreer.

30 large white beans, in 10-inch seed-pans, sown 1 inch deep.
No. 1, profusely watered.

No. 2, sparingly watered.

SOWN MAY 4, 6 P. M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES. MAY.												SPROUTINGS. MAY—JUNE.										
	4th, 6 p. m.	6th, 10 a. m.	6th, 2 p. m.	6th, 6 p. m.	7th, noon.	8th, 5 p. m.	9th, 5 p. m.	11th, 6 p. m.	14th, 6 p. m.	21st, 6 p. m.	23rd, 7 p. m.	Total.	16	18	20	21	1	4	5	9	13	Total.	Per Cent.
No. 1, Profusely watered	16	9		4	9	10	7		4	7	6	72 oz.		**3**	1							4	**13⅓**
No. 2, Spari'gly watered	4		2		3	5	5	3	5	7	4	38 oz.	**3**	1	1	1	2	4	2	1	1	16	**53⅓**

Epitome.—There was a gain in rapidity of sprouting in the drier pan, and 40 per cent. gain in per cent. of sprouting. The seeds appear to have been poor from the first.

Beans of which the epidermis was slightly broken were taken from the same package, and tested in the same manner with the following results :

27. **Lima Bean,** *Large White.*—Dreer. (Compare with No. 26.) Fig. 4.

28 beans, of which the epidermis had been slightly broken in threshing or cleaning, in 10-inch seed-pans, sown one inch deep.

No. 1, profusely watered.

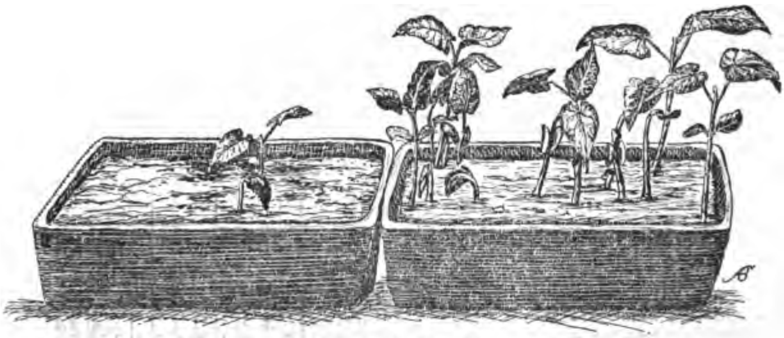
No. 2, sparingly watered.

SOWN MAY 4, 6 P.M.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES. MAY.												SPROUTINGS. MAY.							
	4th, 6 p. m.	6th, 10 a. m.	6th, 2 p. m.	6th, 6 p. m.	7th, noon.	7th, 5 p. m.	8th, 5 p. m.	9th, 5 p. m.	10th, 5 p. m.	11th, 6 p. m.	14th, 6 p. m.	To-tal.	11	13	15	16	20	22	To-tal.	Per cent.
No. 1, Profusely watered,	16	9		4	9		10	7			4	59 oz.	2						2	7 1-7
No. 2, Sparingly watered,	4		2		3	2	5	5	3	3	5	32 oz.		2	3	6	1	10	22	**78.5**

Epitome.—Per cent of sprouting was over 70 per cent. greater in the drier pan. This was due to the fact that more of the beans rotted in the wet pan. On May 22nd, twenty-six of the beans in the wet pan were rotten. Only six were rotten in the drier pan and ten were sprouting. It is known that seeds with a slight surface abrasion often germinate better than those which are uninjured ; but this test indicates that great care must be exercised to water such seeds sparingly, as they are more likely to rot.

Figure 4, from a photograph, represents this test on May 20th.



Wet Pan. Fig. 4.—Table 27. *Dry Pan.*

28. Cobœa scandens.—Vaughan.

50 seeds, in 10-inch seed-pans, planted on edge, the middle of the seed being ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 4, NOON.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES. MAY—JUNE. 4th, noon.	6th, 10 a. m.	6th, 2 p. m.	7th, noon.	8th, 5 p. m.	9th, 5 p. m.	10th, 5 p. m.	11th, 6 p. m.	14th, 6 p. m.	17th, 6 p. m.	18th, 6 p. m.	20th, 6 p. m.	21st, 4 p. m.	23d, 7 p. m.	25th, 6 p. m.	28th, 6 p. m.	30th, 6 p. m.	2nd, 6 p. m.	6th, 5 p. m.	9th, 5 p. m.	Total.
No. 1, Profusely watered,	16	9		8	8	6	5	3	6		4	5	5	4	5	6	6	4	6	6	112 oz.
No. 2, Sparingly watered,	8		2	3	6	6	5	3	5	6	4		5	4	5	6	6				74 oz.

SAMPLES.	SPROUTINGS. MAY—JUNE. 18	20	21	24	25	28	1	4	Total.	Per Cent.
No. 1, Profusely watered,	2	5	4					1	12	**24**
No. 2, Sparingly watered,		4	6	1	1	1	5		18	**36**

Epitome.—The differences in rapidity between these tests are not pronounced, although the per cent. is considerably higher in the drier pan. Owing to an accident, pan No. 2 became very wet June 1, and it was discarded. At this time thirty of the unsprouted seeds were rotten. This indicates that the common advice of catalogues to keep cobœa seeds nearly dry during sprouting is correct, as even in the drier pan over half the seeds rotted. The seeds were probably not good, else the totals of sprouting would have been greater.

29. Cobœa scandens.—Vaughan.

50 seeds, in 10-inch seed-pans, planted flatwise, ½ inch deep.
No. 1, profusely watered.
No. 2, sparingly watered.

SOWN MAY 4, NOON.

SAMPLES.	AMOUNTS OF WATER, IN OUNCES. MAY—JUNE.																				
	4th, noon.	6th, 10 a. m.	6th, 2 p. m.	7th, noon.	8th, 5 p. m.	9th, 5 p. m.	10th, 5 p. m.	11th, 6 p. m.	14th, 6 p. m.	17th, 6 p. m.	18th, 6 p. m.	20th, 6 p. m.	21st, 4 p. m.	23rd, 7 p. m.	25th, 6 p. m.	28th, 6 p. m.	30th, 6 p. m.	2nd, 6 p. m.	6th, 5 p. m.	9th, 5 p. m.	Total.
No. 1, Profusely watered,	16	9		8	8	6	5	3	6		4	5	5	4	5	6	6	4	6	6	112 oz
No. 2, Sparingly watered,	8		2	3	6	6	5	3	5	6	4		5	4	5	6	6	4	6	6	90 oz

SAMPLES.	SPROUTINGS. MAY—JUNE.												
	16	17	18	20	21	23	24	25	27	28	1	Total.	Per Cent.
No. 1, Profusely watered.	1	1	2		1					1	1	7	14
No. 2, Sparingly watered,				1	8	1	3	2	1			16	32

Epitome.—Here, as in the preceding test, rapidity of sprouting is not markedly different in the two cases, but the total is twice larger in the drier pan.

CONCLUSIONS Drawn from the Tests with Different Quantities of Water.

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1. The quantity of water applied to seeds under test may make a remarkable difference in the results.

2. Sprouting is decidedly more rapid in tests which receive less than the usual amounts of water given in green-houses. This is markedly the case in all the tests, with the exception of three indifferent and comparatively unimportant instances, (Nos. 27, 28 and 29).

3. Per cent of sprouting is much greater, as a rule, in the drier tests.

4. The addition of water above the amount to keep the earth simply moist, is injurious.

5. The wide differenees between the results of the wet and moist tests, are not necessarily due to the rotting of the seeds in the wet tests. This is shown in the tests with cucumber seeds, (Nos. 18 and 19), in which the drier tests gave similar or even smaller totals than the wet tests.

III. INFLUENCES OF THE SOAKING OF SEEDS BEFORE SOWING.

It is a common practice in both field operations and seed-testing to soak seeds in water before sowing. The following tests indicate very clearly the leading results of this custom. In this connection it is interesting to study results with the Geneva seed-tester, which tests seeds by soaking them. A number of tests were made with the Geneva tester in comparison with sowing in potting soil in forcing house. The results, which are too extended to be detailed here, indicate that higher sprouting tests are given by the Geneva tester than by planting under known conditions. Ten tests in each case with Marblehead Mammoth Cabbage seeds gave an average germination of 88 per cent. in the tester, against 77.6 per cent. in the soil. The earliness at which the sprouting is visible in the tester, renders testing expeditious. But it must be remembered that full germination cannot often be secured in the apparatus. (Cf. § IX.)

30. Carrot, *Early Forcing*.—Thorburn.

100 carpels in 10-inch seed-pans, sown ½ inch deep in sand.
No. 1, dry.
No. 2, soaked in water 10 hours before sowing.
No. 3, soaked in water 36 hours before sowing.

SOWN MAY 18.

SAMPLES.	SPROUTINGS. MAY—JUNE.										Total.	Per Cent.
	25	26	27	28	29	30	31	1	2	3		
No. 1, Dry,	1	5	17	35	8	1	2			1	70	**70**
No. 2, 10 hours,	5	12	14	32	11	1	1	1	1		78	**78**
No. 3, 36 hours,		12	16	31	3	2	3	2	1		70	**70**

Epitome.—Sprouting was most rapid in the seeds which had been soaked 10 hours, and slowest in those which had not been soaked. The total percentages were essentially the same, although the seeds soaked 10 hours gave the best results by 8 per cent.

31. Carrot, *Vermont Butter*.—Hoskins.

100 carpels in 10-inch seed-pans, ½ inch deep in sand.
No. 1, dry.
No. 2, soaked 24 hours.
No. 3, soaked 36 hours.

SOWN MAY 21.

SAMPLES.	SPROUTINGS. MAY.			JUNE.				Total.	Per Cent.
	29	30	31	1	2	3	4		
No. 1, Dry,		15	35	11	4			65	**65**
No. 2, 24 hours,		3	54	14	6	3		80	**80**
No. 3, 36 hours,	1	23	36	8	5		1	74	**74**

Epitome:—Sprouting was most rapid in the sample soaked 36 hours, although at the end of the third day there was little difference in the results, those soaked 36 hours showing 60 per cent. of sprouting, those soaked 24 hours showing 57 per cent., and the dry sample 50 per cent. Total sprouting was greatest in the 24-hour sample, although but 6 per cent. higher than in the 36-hour sample. The dry sample showed a considerable lower figure.

32. Tomato, *Green Gage*.—Thorburn.

100 seeds in 10-inch seed-pans, ½ inch deep in sand.
No. 1, dry.
No. 2, soaked 8 hours.
No. 3, soaked 46 hours.

SOWN MAY 18.

SAMPLES.	SPROUTINGS. MAY—JUNE.													Total.	Per Cent.
	25	26	27	28*	29	30	31	1	2	3	4	5	6		
No. 1, Dry,				**21**	19	10	12	6	3	1				72	**72**
No. 2, 8 hours,	**2**		**4**	**30**	8	12	5	4	3		1			69	**69**
No. 3, 46 hours,	**1**	**8**	**21**	**22**	7	1	8	1	1	1		1	1	73	**73**

Epitome.—Sprouting was most rapid in the 46-hour sample, and slowest in the dry sample. Totals of sprouting were not essentially different.

33. Tomato, *Belle*.—Cornish.

100 seeds in 12-inch seed-pans, ½ inch deep in sand.
No. 1, dry.
No. 2, soaked 24 hours.

* The sudden increase in sprouting on the 28th, in this and the next test, was due to the turning on of steam, necessitated by the unprecedented cold weather. Fire had been out for some days.

SOWN MAY 2.

SAMPLES.	SPROUTINGS. MAY. 7	8	9	10	Total.	Per cent.
No. 1, Dry,		18	21	4	43	**43**
No. 2. 24 hours,	15	73	4	1	93	**93**

Epitome.—Sprouting was decidedly more rapid in the soaked seeds, and the totals were 50 per cent. more in the same instance. This test is unlike all others made in this series in its total results, and is evidently abnormal. The test was twice repeated, with the following results:

34. Tomato, *Belle.*—Cornish.

100 seeds, sown in 12-inch seed-pans, ½ inch deep in sand.
No. 1, dry.
No. 2, soaked 24 hours.

SOWN MAY 15.

SAMPLES.	SPROUTINGS. MAY. 20	21	22	23	24	25	26	27	28	29	31	Total.	Per Cent.
No. 1, Dry,	1	11	38	17	7	3	3		5	1		86	**86**
No. 2, 24 hours,	4	26	32	5	3	5	1	1	5		1	83	**83**

Epitome.—Sprouting was more rapid in the soaked seeds, but the totals were essentially the same in the two cases.

35. Tomato, *Belle.*—Cornish.

100 seeds in 12-inch seed-pans, ½ inch deep in sand.
No. 1, dry.
No. 2, soaked 24 hours.

SOWN JUNE 7.

SAMPLES.	SPROUTINGS. JUNE. 12	13	14	15	16	17	18	Total.	Per Cent.
No. 1, Dry,		3	50	27	11	5		96	**96**
No. 2, 24 hours,	6	66	11	3	2		1	89	**89**

Epitome.—Sprouting was very decidedly more rapid in the soaked seeds, but the total was 7 per cent. less than in the dry sample.

36. Turnip, *Early Six Weeks.*—Department of Agriculture.

100 seeds in 8-inch lily-pans, ¼ inch deep in sand.
No. 1, dry.
No. 2, soaked 15 hours.

SOWN MAY 21.

SAMPLES.	SPROUTINGS.									
	MAY—JUNE.								Total.	Per Cent.
	26	27	28	29	30	31	1	2		
No. 1, Dry,	**7**	62	9	8	4	1	1	3	95	**95**
No. 2, 15 hours,	**36**	33	16	3	2	4			94	**94**

Epitome.—Sprouting was more rapid in the soaked sample. Totals were essentially the same.

37. Radish, *Early Scarlet Globe.*—Henderson.

100 seeds in 20-inch seed-flats, ½ inch deep in potting earth.
No. 1, soaked 12 hours.
No. 2, soaked 24 hours.

SOWN APR. 27.

SAMPLES.	SPROUTINGS.											
	APRIL—MAY.										Total.	Per cent.
	29	30	1	2	3	4	5	6	9	11		
No. 1, 12 hours,	**9**	**40**	22	5	1	1	1	1			80	**80**
No. 2, 24 hours,		**13**	44	11	4	5	2	1	1	1	82	**82**

Epitome.—Sprouting was decidedly more rapid in the 12-hour sample, while the totals were essentially the same.

38. Radish, *Early Scarlet Globe.*—Henderson. (Compare with No. 37.)

100 seeds in 20-inch seed-flats, ½ inch deep in potting earth.
No. 1, dry.
No. 2, soaked 6 hours.

SOWN MAY 3.

SAMPLES.	SPROUTINGS.							
	MAY.						Total.	Per Cent.
	6	7	8	9	11	12		
No. 1, Dry,	**5**	**56**	3	5	1	1	71	**71**
No. 2, 6 hours,	**2**	**58**	4	7		1	72	**72**

Epitome.—There were no marked differences in results between these tests, owing, no doubt, to the fact that the soaking of the second sample, was not long enough continued. In comparison with No. 37, it is found that quickest returns were obtained from the sample soaked 12 hours.

39. Onion, *Giant Yellow Globe Rocca.*—Department of Agriculture.

50 seeds in 5-inch seed-pans, ¼ inch deep in sand. Nos. 1–3, in forcing-house; Nos. 4–6, in incubator.

No. 1, soaked 10 hours.
No. 2, soaked 20 hours.
No. 3, soaked 30 hours.
No. 4, soaked 10 hours.
No. 5, soaked 20 hours,
No. 6, soaked 30 hours.

SOWN MARCH 29.

SAMPLES.	SPROUTINGS.										
	APRIL.									Total.	Per Cent.
	3	4	5	6	7	8	9	10	11		
FORCING-HOUSE:											
No. 1, 10 hours,		6	13	15	9		2			45	**90**
No. 2, 20 hours,		3	14	8	6	2	1	1	2	37	**74**
No. 3, 30 hours,		7	18	11	6		1		1	44	**88**
INCUBATOR:											
No. 4, 10 hours,	7	17	11	3	2		3	1		44	**88**
No. 5, 20 hours,	9	8	6	3	2	1	2	1	1	33	**66**
No. 6, 30 hours,		11	14	5	4	3			2	39	**78**

Epitome.—The results are conflicting, and indicate that marked differences from different periods of soaking are less likely to occur in onions than in some other seeds.

CONCLUSIONS Drawn from the Foregoing Tests upon the Influences of Soaking upon the Sprouting of Seeds.

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1. Great gain in rapidity of sprouting, counting from the time of planting, may be expected as a rule, if seeds are previously soaked in water; and the longer the seeds are soaked, within reasonable limits, the greater is usually the gain in rapidity of sprouting. This fact is interesting, in face of the experience that very profuse watering after sowing gives an opposite result. (Cf. § II.)

2. This gain in rapidity of sprouting in soaked samples is really fictitious, however, inasmuch as germination actually begins in the soaked seeds before the dry samples are sown. In truth, the soaked seeds are sown earlier than the dry ones. If this advance in period of sowing is added to the date of sowing of the dry seeds, it will be found that dry seeds as a rule sprout fully as early as soaked seeds, and many times much earlier.

3. Total amount of sprouting does not appear to be influenced by soaking.

4. Similar results are not to be expected from all species of plants.

IV. INFLUENCES OF CHARACTER OF SOIL UPON SPROUTING.

It is well known that texture of soil often has much to do with the germination of seeds in the field. Soils which bake, which become very dry, or which hold too much moisture, always tend to give a poor "stand" of crop. But the soils used in houses are such as to occasion no thought of their influence upon germination ; yet there are cases in which such soils cause variation in seed tests. This was particularly marked in a lot of beans which we tested this spring. Samples happened to be sown at the same time in potting soil on a bench, and under a cloth on the surface sand. Those in soil gave much poorer germinations than the others. Other sowings were therefore made from the same lot at given depths in sand for purposes of comparison. The figures cannot be presented in the limited space of this article, but it was found that sproutings were in some cases nearly twice as many in sand as in potting soil. More beans rotted in the soil than in the sand. The soil had not been sifted, and it contained some manure, yet it was only four inches deep on the bench and it would seem that the drainage was good. Our tests in this direction warrant the following

CONCLUSIONS.

1. Variations in results of testing may sometimes be expected in consequence of character of soil in which the tests are made.

2. In the present instance, low results in potting soil as compared with tests in sand, appear to be due to the greater amount of water held in the earth, causing the seeds to rot. The results may, therefore, be studied in connection with those upon the influence of varying amounts of watering. (Cf. § II.)

V. INFLUENCES OF LIGHT UPON THE SPROUTING OF SEEDS.

"On other occasions, from the want of time, the seeds, instead of being allowed to germinate on damp sand, were sown on the opposite sides of pots, and the fully grown plants measured. But this plan is less accurate, as the seeds sometimes germinate more quickly on one side than on the other. It was, however, necessary to act in this manner with some few species, as certain kinds of seeds will not germinate well when exposed to the light. . . . . This occurred in the plainest manner with the seeds of *Papaver vagum* and *Delphinium Consolida*, and less plainly with those of *Adonis æstivalis* and *Ononis minutissima*. Rarely more than one or two of the seeds of these four species germinated on the bare sand, though left there for some weeks; but when these same seeds were placed on earth in pots, and covered with a thin layer of sand, they germinated immediately in large numbers."—*Darwin, Cross and Self Fertilization, Amer. ed. 13.*

Of late years there has been more or less said concerning the sowing of seeds for test upon the surface of soil and covering with glass, in order that every seed may be watched, and certain seed testing apparatuses have been devised upon this principle. It appears from Darwin's experience that with some seeds grave errors may occur from this practice, and further evidence of the same nature is furnished from the tests here recorded. The seeds, in the following trials, were sown upon the surface of soil in pots or pans, the pots, unless otherwise mentioned, being plunged in sphagnum moss, to keep the soil moist. Over the top of the pot or pan was placed a pane of glass, or a close fitting iron saucer or a board.

40. Papaver Rhœas, *English Poppy*.—Henderson.

50 seeds on sand, in 4-inch pots plunged in sphagnum.
No. 1, covered with glass.
No. 2, covered with a plate. SOWN MAY 27.

SAMPLES.	SPROUTINGS.												Total.	Per Cent.
	JUNE.													
	1	2	3	4	5	6	7	8	9	10				
No. 1, In light,			**3**	9	3	2	1	7	3				28	**56**
No. 2, In darkness,	**14**	**10**	**6**	3	1					3			37	**74**

Epitome.—Sprouting was very much slower in the seeds exposed to light, and total sprouting was 18 per cent. less in the same case.

41. Larkspur, *Dwarf Rocket.*—Vaughan.

100 seeds on sand, in 4-inch pots plunged in sphagnum.
No. 1, light-colored seeds covered with glass.
No. 2, light-colored seeds covered with a plate.
No. 3, dark-colored seeds covered with glass.
No. 4. dark-colored seeds covered with a plate. SOWN MAY 10.

SAMPLES.	SPROUTINGS. MAY—JUNE.							Total.	Per Cent.
	26	28	2	8	12	22			
Light Colored Seeds.									
No. 1, In light,								0	0
No 2, In darkness,	1	1	11		3	4		20	20
Dark-Colored Seeds.									
No. 3, In light,								0	0
No. 4, In darkness,	4	6	10	5	2	3		30	30

Epitome.—There were no sproutings in the seeds exposed to light. The low totals in the seeds which sprouted indicate that this method of sowing is not advisable, for other samples of these seeds germinated well when sown in the ordinary manner.

42. Adonis æstivalis.—Henderson.

25 seeds on sand, in 4-inch pots plunged in sphagnum.
No. 1, covered with glass.
No. 2, covered with a plate. SOWN MAY 27.

SAMPLES.	SPROUTINGS. JUNE.						Total.	Per Cent.
	8	9	11	13	15	21		
No. 1, In light,			1				1	4
No. 2, In darkness,	3	3	4	1	3	3	17	68

Epitome.—But one seed sprouted in the samples exposed to light, and even this seed had become embedded in the sand so as to be but partially exposed.

43. Radish, *Early Scarlet Globe.*—Henderson.

100 seeds on sand, in 5-inch seed-pans.
No. 1, covered with glass.
No. 2, covered with a board. SOWN MAY 27.

SAMPLES.	SPROUTINGS. MAY—JUNE.								Total.	Per Cent.
	29	30	31	1	2	3		5*		
No. 1, In light,	15	54	2	16		4			91	91
No. 2, In darkness,	2	30	18	16	1	1		3	71	71

* All that remained of No. 1, were decayed at this date; 12 of No. 2 were still souud, but though left two or three days showed no signs of germinating.

The test was repeated with the following result:

SOWN JUNE 11.

SAMPLES.	SPROUTINGS. JUNE.						Total.	Per Cent.
	16	17	18	19	21			
No. 1, In light,	62	13	2	4	1		82	82
No. 2, In darkness,	84	4	3	1			92	92

Epitome.—The two tests with radish seeds show marked differences, yet the totals of sprouting are not very widely dissimilar. The results indicate that light has less influence upon radish seeds than upon seeds of some other plants.

Similar indifferent results were obtained with onion seeds.

CONCLUSIONS from the Test of the Influence of Light upon Sprouting.

1. Very great differences in results may sometimes be expected between samples exposed to light during the process of sprouting, and those kept in darkness.

2. When such differences occur, they indicate that light retards or even wholly prevents germination.

3. In some species this influence of light is greatly marked, while in others it is not apparent.

4. It is apparent that those apparatuses which test seeds by holding them on a porous plate above water, are to be looked upon with distrust, unless provided with an opaque covering; and even then they may prove unsatisfactory, as the experience with the larkspur seeds indicates that best sproutings follow planting in the soil.

VI. WEIGHT OF SEED IN RELATION TO SPROUTING.*

Many experiments have been conducted here this year upon the relation of weight of seed to germination, but the figures are too numerous to be recorded here. The general results of the tests may be indicated, however.

*Most of the work recorded in Sections VI and VII was performed, under the direction of the writer, by Mr. B. R. Wakeman, of the class of 1889, in preparation of a thesis for graduation.

Of itself, *per se*, weight appears to exercise no influence upon germination, but it is often a tolerably accurate measure of viability as determined by various causes. Broadly stated, it may be said that comparative lightness in a seed indicates arrested growth, and consequent lowness of germinative vitality. A few instances may be given:

44. Cabbage, *Flat Dutch.*—Thorburn.

100 seeds in seed-pans, sown ½ inch deep in sand. A parcel of seeds were thrown in a pan of water, and allowed to remain one minute, when 100 of those which sank and 100 of those which floated were chosen for test.

No. 1, heavy seeds (average weight .065 grains).

No. 2, light seeds (average weight .052 grains).

SOWN APRIL 25.

SAMPLES.	SPROUTINGS.									Total.	Per cent.
	4th Day.	5th Day.	6th Day.	7th Day.	8th Day.	9th Day.	10th Day.	11th Day.	12th Day.		
No. 1, Heavy,	**16**	31	18	3	3	3	2		1	77	**77**
No. 2, Light,	4	9	7	2	3	2	2	2	1	32	**32**

Epitome.—Total of sprouting was over twice greater in the heavy samples, and rapidity of sprouting was proportionately greater.

45. Cabbage, *Red Dutch.*—Thorburn.

100 seeds in seed-pans, ½ inch deep in sand.

The samples were separated in the same manner as in the preceding test.

No. 1, heavy seeds (average weight .075 grains).

No. 2, light seeds (average weight .07 grains).

SOWN APRIL 18.

SAMPLES.	SPROUTINGS.						Total.	Per Cent.
	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day		
No. 1, Heavy,	**45**	23	7	1	3		79	**79**
No. 2, Light,	**22**	32	8		4	1	67	**67**

Epitome.—Sprouting was both more rapid and greater in amount in the heavy sample. The difference in total sprouting was less in this test than in No. 44, owing to the much smaller difference in weight between the heavy and light samples.

46. Radish, *Early Scarlet Globe.*—Henderson.

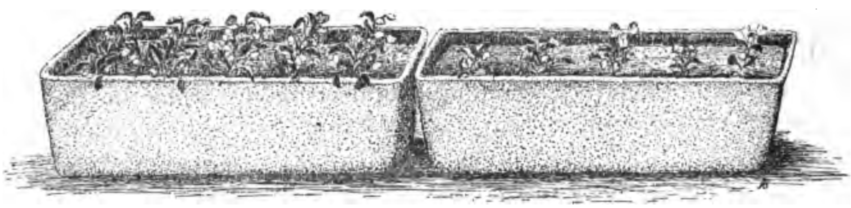
100 seeds in seed-pans, ½ inch deep in sand, selected by hand.*
No. 1, heavy seeds, (average weight 2.53 grains).
No. 2, light seeds, (average weight .13 grains).

SOWN APR 26.

SAMPLES.	SPROUTINGS.					Total.	Per Cent.
	3rd Day.	4th Day.	5th Day.	6th Day.	7th Day.		
No. 1, Heavy,	**13**	48	5	8	4	78	**78**
No. 2. Light,	**6**	30	8	3	3	50	**50**

Epitome.—Sprouting was higher and quicker in the heavy seeds.

Figure 5, from a photograph, illustrates another test with radish seeds, in which the differences were more marked than in the above instance.



Heavy Seeds. Fig. 5—Radish. *Light Seeds.*

It is often true that over-ripe seeds germinate more slowly, and give lower total results than others, and this over-ripeness is sometimes indicated by additional weight. It is to be expected, therefore, that in some instances best results in germination come from the seeds of lighter weight. Possibly the two following tests are instances in point;

47. Bean, *Improved Green Flageolet.*—Department of Agriculture.

25 selected white beans in seed-pans, ¾ inch deep in sand.
No. 1, heavy seeds, (6.25 grains).
No. 2, light seeds, (2 grains).

* In selecting the samples, it is advisable to choose only such seeds as represent nearly the extremes of weight. By thus discarding the intermediate weights, the results become more marked, and give more accurate measures of the relative values of heavy and light seeds.

SOWN APR. 11.

SAMPLES.	SPROUTINGS.			Total.	Per Cent.
	4th Day.	5th Day.	6th Day.		
No. 1, Heavy,	**6**	10	4	20	**80**
No. 2, Light,	**23**	1		24	**96**

48. Lathyrus sativus (*Gesse*).—Michigan Experiment Station.
100 seeds in seed-pans, ½ inch deep in sand.
No. 1, heavy seeds, (7.1 grains).
No. 2, light seeds (3.27 grains).

SOWN APR. 8.

SAMPLES.	SPROUTINGS.							Total.	Per Cent.
	2d Day	3d Day	4th Day	5th Day	6th Day	7th Day	8th Day		
No. 1, Heavy,	1	**3**	61	32	2			99	**99**
No. 2, Light,		**23**	67	5	1	1	1	98	**98**

Epitome.—Light seeds in each case sprouted more rapidly than heavy ones, while in the beans they gave 16 per cent. higher total sprouting.

CONCLUSIONS From Many Tests upon the Influences of Weight of Seed upon its Sprouting.

---

1. Variations in results of testing, both as regards rapidity of sprouting and the total amount, may be expected between seeds of different weights in the same sample.

2. This variation is much greater in some species than in others. In our tests, the variation was particularly marked in cabbage, radish, sweet pea, bean, gesse (*Lathyrus sativus*), burnet (*Poterium Sanguisorba*), martynia, orach.

3. As a rule, the heaviest seeds in any sample give earliest and highest results.

4. In some cases, the lightest seeds in the sample give earliest and highest results, apparently because the heaviest seeds, with which they are compared, are over-ripe ; or, in some instances, under-maturity may result in earlier germinations, and such seeds are sometimes light in weight.

VII. COLOR OF SEED IN RELATION TO SPROUTING.

Color may be assumed to indicate, in most cases, some vital character of the seed, as determined by various causes. In one species, or even in one individual sample, it may indicate a different character than the same color does in another species or sample. It may indicate degree of maturity, method of curing, age of seed, or other peculiarity. It is to be expected, therefore, that color may sometimes designate more or less accurately the germinative vitality of the seed. It follows, however, that no general law of relation of color to germination can be announced: every species, and sometimes every sample, must be investigated for the law which governs itself. Many tests in this direction have been made, but one example will show something of the extent of variation in seeds of different colors:

49. Bean, *Green Flageolet.*—Dreer.

50 beans in soil on a bench.
No. 1, white beans, ½ inch deep.
No. 2, green-colored beans, ½ inch deep.
No. 3, white beans, 1½ inch deep.
No. 4, green-colored beans, 1½ inch deep.

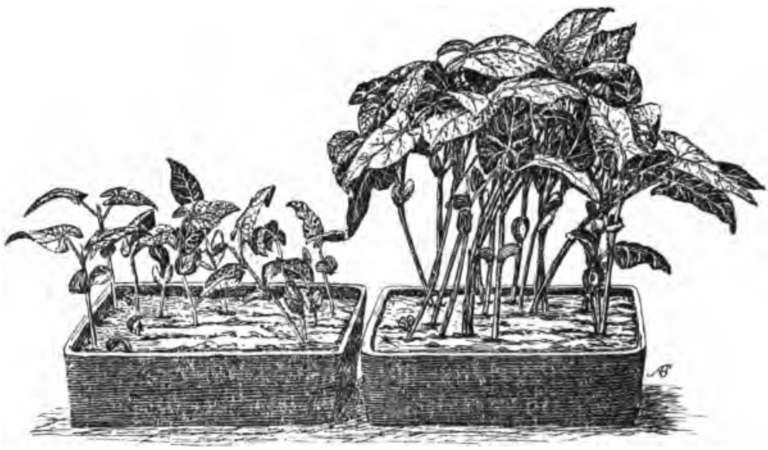
SOWN MAY 6.

SAMPLES.	SPROUTINGS. MAY. 10	11	12	13	14	15	16	17	18	19	Total.	Per Cent.
ONE-HALF INCH DEEP:												
No. 1, White.	9	4	2		2						17	34
No. 2, Green-colored,	24	9	7	1	1	1	1				44	88
ONE AND A HALF IN. DEEP:												
No. 3, White,			3	9		1	1	2		2	18	36
No. 4, Green-colored,		1	8	7	7	6	5	3	4		41	82

Epitome.—Sproutings were most rapid, and higher in total per cent. in the green-colored samples.

This test was twice repeated with similarly marked results. The same variety from the Department of Agriculture gave opposite results, however.

Fig. 6 shows tests of white and green-colored Lima beans, sown at the same time. The green-colored seeds are ahead. The white sample is the No. 2 of Table 26. The other had the common care of the forcing-house.



White Seeds. Fig. 6—Lima Bean. *Green-Colored Seeds.*

Four tests with Morning Glories (both *Convolvulus major* and *C. minor*) gave results uniformly in favor of white seeds as contrasted with black ones in the same sample.

From a considerable study of the importance of color in relation to germination, we have drawn the following

CONCLUSIONS.

1. Seeds which differ widely in color in any sample frequently give different results under test.

2. This variation in results may lie in greater rapidity of sprouting, or in higher total amounts, or in both.

3. The relative values of seeds of different colors vary with each species, or sometimes with each sample.

VIII. INFLUENCES OF LATITUDE UPON THE SPROUTING OF SEEDS.

Plants of high latitudes are more sensitive to heat and cold than those of the same species growing nearer the equator, *i. e.*, they start or vegetate relatively earlier in Spring. This subject has been investigated in several directions, but, so far as the writer is aware, it has not been pursued in this country in relation to germination of seeds.* The following tests are incidental to this investigation, being a part of a general series of researches upon the influence of latitude upon plants, but they are suggestive in this connection.

A sample of white dent corn was secured from the Alabama Experiment Station, and samples of white and yellow dents were obtained from the South Carolina Station. The germination of these samples was compared with that of corn grown on the farm of this University.

50. **Corn,** from different latitudes, 50 kernels in each sample, sown one inch deep in 12-inch seed pans. (Fig. 7.)

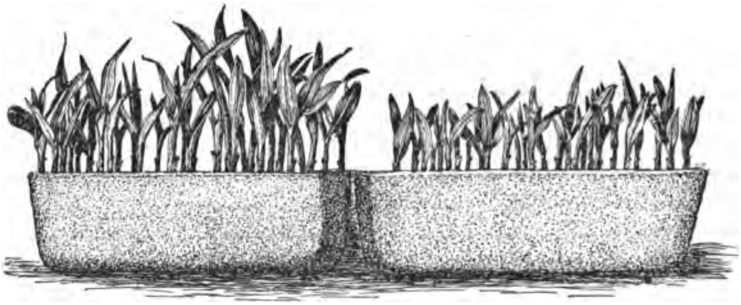
No. 1, yellow dent (*Pride of the North*), from Ithaca.
No. 2, yellow dent, from South Carolina.
No. 3, white dent, from South Carolina.
No. 4, white dent, from Alabama.

SOWN MARCH 19.

SAMPLES.	SPROUTINGS.					Total.	Per Cent.
	MARCH.						
	23	24	25	26	27		
No. 1, Ithaca,	14	33	2			49	98
No. 2, South Carolina,		35	12	1		48	96
No. 3, South Carolina,		29	15	3	2	49	98
No. 4, Alabama,		34	5	1		40	80

Epitome.—Sprouting was much the most rapid in the New York corn, but differences in totals were evidently not due to influence of latitude. The difference in rapidity of germination was much more marked than would appear from the table. The plants from New York seed were by far the largest and most vigorous of any in the test during the month which they remained in the house. The Alabama seed gave the least vigorous plants, while the South

Carolina seeds gave intermediate results. Figure 7, from a photograph, illustrates the New York and Alabama samples, ten days after sowing.



Ithaca. Fig. 7—Table 50. *Alabama.*

Three other tests were made, with the same result. In one test the sample from New York was represented by seed taken from a crib of soft corn, yet this sample gave earliest results, though less marked than in the other instances.*

CONCLUSION.

Northern grown corn appears to germinate more quickly than southern grown corn.

IX. VARIATIONS IN DUPLICATE TESTS UNDER LIKE CONDITIONS.

It may be well to briefly call attention to the fact that scarcely any two tests made with seeds from the same sample, under conditions apparently identical, are exactly alike in results. It frequently happens that these results are so dissimilar as to give us no warrant for expressing an opinion of the value of a sample, from two or three tests. The variation in a certain tomato test recorded in this paper, (Cf. Nos. 33 and 34), may be taken as an illustration in point. The following table shows the variations between twenty tests:

*A similar lesson appears to be taught by the behavior of the seeds of species of Carex, which were planted this spring. Of some 80 pots of seeds, collected by the writer in Europe last year, 13 show germination at the present time, and of these, all the most forward, with two exceptions, are northern species, collected in Scotland.

51. **Cabbage,** *Marblehead Mammoth.*—Department of Agriculture.

50 seeds in each of ten tests in both the Geneva tester,* bearing folds of cotton flannel, and in potting soil in forcing-house.

Series I.—Tests in Geneva tester.

Series II.—Tests in earth.

SERIES I—GENEVA TESTER.				SERIES II—EARTH.			
Average per cent. of Sprouting	Actual per cents. of Sprouting	Per cent. of variation from the mean.	Average per cent. of variation.	Average per cent. of Sprouting	Actual per cents. of Sprouting	Per cent. of variation from the mean.	Average per cent. of variation.
	72	16			58	19 6	
	80	8			70	7.6	
	82	6			72	5.6	
	86	2			78	.6	
88	90	2	6.4	77.6	80	2.6	6.7
	92	4			80	2.6	
	94	6			82	4.6	
	94	6			82	4.6	
	94	6			84	6.6	
	96	8			90	12.6	

CONCLUSIONS.

1. One test cannot be accepted as a true measure of any sample of seeds,

2. Variation in duplicate tests is likely to be greater when seeds are planted in soil than when tested in some sprouting apparatus like the Geneva tester. (Cf. introduction to § III.)

X. COMPARISONS OF RESULTS OF SEED-TESTS WITH RESULTS OF ACTUAL SOWING IN THE FIELD.

It has been said recently that the ideal test of seeds is actual sowing in the field, inasmuch as the ultimate value of the seed is its capability to produce crop. This notion of seed tests is obviously fallacious, although the statement upon which it is based is true. In other words, actual planting rarely gives a true measure of the capabilities of all the seeds of any sample, because of the impossibility to control conditions and methods in the field. The

*** This apparatus holds the seeds in pockets of cloth which hang over a pan of water. For a full description, see Second Rep. N. Y. Exp. Sta. 67.**

object of seed tests is to determine how many seeds are viable and what is their relative vigor; if planting shows poorer results, because of covering too deeply or too shallow, by exposing to great extremes of temperature or moisture or a score of other untoward conditions, the sample cannot be held to account for the shortcoming. The following table indicates the extent of variation which may be expected between tests and actual plantings of seeds from the same samples:

52. Various samples tested in-doors and actually planted in the field. The seeds were sown in the field June 5, and the last notes were taken from them July 5. They were sown on a gravelly knoll. Rain fell about every alternate day, and the soil was in good condition for germination throughout the month. The in-door tests were made in loose potting earth, or in sand in seed-pans.

SAMPLES.	No. of Germ. in house.	Per Cent. of Germ. in house.	No. of Germ. in field. (200 Seeds sown.)	Per Cent. of Germ. in field.	Per Cent. of Difference.
Endive, *Green-Curled*, Thorburn.	200 Seeds. 88	44	53	26.5	**17.5**
Tomato, *Green Gage*, Thorburn.	100 Seeds. 72	72	93	46.5	**25.5**
Turnip, *Early Six Weeks*, Dept. of Agriculture.	200 Seeds. 180	90	65	32.5	**57.5**
Pea, *White Garden Marrowfat*, Thorburn.	60 Seeds. 55	91.6	181	90.5	**1.1**
Celery, *White Plume*, Thorburn.	100 Seeds. 41	41	22	11	**30**
Onion, *Red Wethersfield*, Thorburn.	200 Seeds. 148	74	84	42	**32**
Carrot, *Early Forcing*, Thorburn.	100 Seeds. 70	70	39	19.5	**50.5**
Carrot, *Vermont Butter*, Hoskins.	100 Seeds. 65	65	45	22.5	**42.5**

CONCLUSION.

1. The table indicates that actual planting in the field gives fewer germinations than careful tests in conditions under control. This difference in total of germination, even under favorable conditions of planting, may amount to over 50 per cent.

2. In planting, due allowance should be made for the comparatively bungling methods of field practice by the use of greater quantities of seeds than would seem, from the results of tests, to be sufficient.

XI. IMPURITIES IN SAMPLES OF GARDEN SEEDS.

Over one hundred packages of seeds have been carefully examined for impurities, and in ninety separate instances the results have been tabulated and compared. This examination consisted in counting every seed in the sample, counting the impurities, weighing the seeds and the impurities, and determining, so far as possible, the character of the impurities. The percentages of impurities, both by number and weight, have been calculated. From these analyses it is easy to draw conclusions as to the probable extent of adulteration or impurity in garden seeds. No evidence of adulteration was found, and weed seeds were few and unimportant. In some cases the sample had not been properly cleaned, but in general the more important seeds were very free from impurities. The impurities were very largely immature and imperfect seeds. The average of impurities, by number, was found to be 2.76 per cent., and by weight, 1.38 per cent. The investigation appears to indicate that there is no necessity for seed-control stations in this country, for the purpose of preventing dishonesty and carelessness in the sale of garden seeds. The detailed results will soon appear in *Agricultural Science*.

GENERAL SUMMARY.

I. The results of a seed-test depend very largely upon the known conditions under which the test is made :

1. Variations in temperature may cause variations in rapidity of sprouting.

2. An essentially constant temperature of about 74° gives quicker results than an ordinarily variable temperature of a similar mean.

3. It is probable that any constant temperature gives quicker results than a variable temperature of which the mean is the same as the constant temperature.

4. As the mean temperature lowers, sprouting, as a rule, becomes slower.

5. In some instances, greater rapidity of sprouting due to a constant temperature of 74°, does not appear to be correlated with greater per cent. of total sprouting. In beans, however, greater per cent. of sprouting appears to follow greater rapidity of sprouting.

6. There is probably a tolerably well-defined optimum temperature for each species of plant, in which best results from seed-tests can be obtained. This limit is not closely determined for most garden seeds.

7. The quantity of water applied to seeds may determine both the rapidity and per cent. of sprouting.

8. A comparatively small amount of water gives quickest and largest results.

9. Greater quantities of water than are required for best results, lessen rapidity and per cent. of sprouting either by causing the seeds to rot or by retarding germination, or by both.

10. The soaking of seeds in water before planting does not appear to hasten sprouting, if the planting time is reckoned from the time at which the seeds are put to soak. But if planting time is counted from the time of placing the seeds in soil, quicker sproutings are the result; this method of reckoning is incorrect, however.

11. The soaking of seeds does not appear to influence the total amount of sprouting.

12. The results of soaking appear to vary in different species.

13. The character of soil in which the test is made may influence the results, both in rapidity and per cent. of sprouting.

14. Light has great influence upon the sprouting of the seeds of some species.

15. When light has any influence, it retards or wholly prevents sprouting.

16. The effects of light upon sprouting are different in different species.

17. The weight of the seed is often a tolerably accurate measure of its viability, as determined both by rapidity and per cent. of sprouting.

18. As a rule, heavy seeds germinate better than light ones of the same sample.

19. Seeds of different species may vary in sprouting in reference to weight.

20. The color of the seed in some cases is a tolerably accurate measure of rapidity and per cent. of sprouting.

21. When there is any variation in viability in reference to color, it is usually found that the stronger sproutings occur in the darker colored seeds.

22. The relative values of seeds of different colors vary with each species, or sometimes with each sample.

23. The latitude in which seeds are grown may determine their behavior in germination.

24. Northern grown corn appears to germinate quicker than southern grown corn. It is to be expected, from our knowledge of the variation of plants in reference to latitude, that seeds of most species will give similar results.

25. Variation in results of seed-tests may be due to the apparatus in which test is made.

26. Those apparatuses in which the seeds are exposed to light are to be distrusted.

27. Those apparatuses which afford no protection to the seeds other than a simple layer of cloth, paper, board, or similar cover, are usually unsafe, from the fact that they allow of too great extremes in amounts of moisture. (Cf. Tables 2, 3, and 41.)

28. The so-called Geneva tester appears to give better results of sprouting than tests made in soil, probably from the fact that moisture and temperature are less variable than in the soil tests.

29. In order to study germination to its completion, tests must be made in soil.

30. Tests made in-doors are more reliable than those made in the field.

II. Results commonly vary between tests made under apparently identical conditions, even with selected seeds. Therefore,

31. One test cannot be accepted as a true measure of any sample of seeds.

III. The results of actual ordinary planting in the field cannot be considered a true measure of the viability or value of any sample.

IV. Rapidity of sproutings, unless under identical conditions, is not a true measure of vitality or vigor of seeds.

V. There appears to be no pernicious adulteration of garden seeds in this country, and, as a rule, there are no hurtful impurities.

In the ordinary farmer's garden seed-testing is perhaps of little or no value, but to the market gardener, who plants considerable areas to special crops, and to the seedsman, it is highly profitable. It is possible that in some cases the character of the crop can be prognosticated with some degree of certainty from behavior of plants in germination, wholly aside from percentages of sprouting. The studies of experts in this country and Germany indicate that when accurate information is desired as to the value of seeds, the seed-test should present at least the following data: Name of variety; where grown; when grown; how kept; per cent. by weight of foreign matter; per cent. by weight of apparently good seeds; nature of foreign material; weight of seeds; manner of testing; number tested; average and extreme temperatures during trial; first germinations in hours; last germinations in hours; per cent. by number germinated; per cent. unsprouted but sound at end of trial; date of test; estimate of agricultural value.

L. H. BAILEY.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

AGRICULTURAL DEPARTMENT.

VIII.

AUGUST, 1889.

On the Effect of Different Rations on Fattening Lambs.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

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CORNELL UNIVERSITY EXPERIMENT STATION,
Ithaca, N. Y.

THE EFFECT OF DIFFERENT RATIONS ON FATTENING LAMBS.

THESE experiments were, in the main, a continuation of those carried on at this station one year ago, and reported in Bulletin No. II, and very nearly the same foods were used, none of them being out of the reach of the general mass of farmers.

GENERAL PLAN OF THE EXPERIMENT.

The period of feeding lasted five full months, from November 25th, 1888, to April 25th, 1889. The lambs, twelve in number, were selected from a lot that had been picked up in the surrounding country for shipment. They were coarse wool grades, Shropshire or Southdown, dropped late the previous spring, and had evidently been scantily fed during the summer. They were not such animals as would have been selected to give the best financial results, but being thin in flesh and fairly uniform, were well adapted to the purposes of the experiment. The twelve were closely shorn, and then divided into four lots of three each, in such a manner as to have as nearly as possible an equal weight in each lot. Three lambs were used in each lot, so that if for any reason there should be an accident to one there might be two left at the end, from which to gather data in regard to the effects of the rations.

The lots were numbered respectively III, IV, V and VI, and each lamb was labeled with a separate numbered ear tag, so that data in regard to increase in weight, etc., could be collected individually and by lots.

The experiment progressed satisfactorily from beginning to end, with but two exceptions. Lamb No. 12, in lot III, made scarcely any growth from beginning to end, as shown by the weekly weighings. Lamb No. 18, in lot IV, grew and thrived as well as any until about February 1st, when it began to lose weight, though not noticeably ailing. About March it became sick, refused to eat, and was doctored for costiveness, but continued to grow worse, and died March 13. A post mortem examination showed that death was caused by a stone in the bladder. For these reasons all the figures and computations are based upon the two heaviest lambs in each lot.

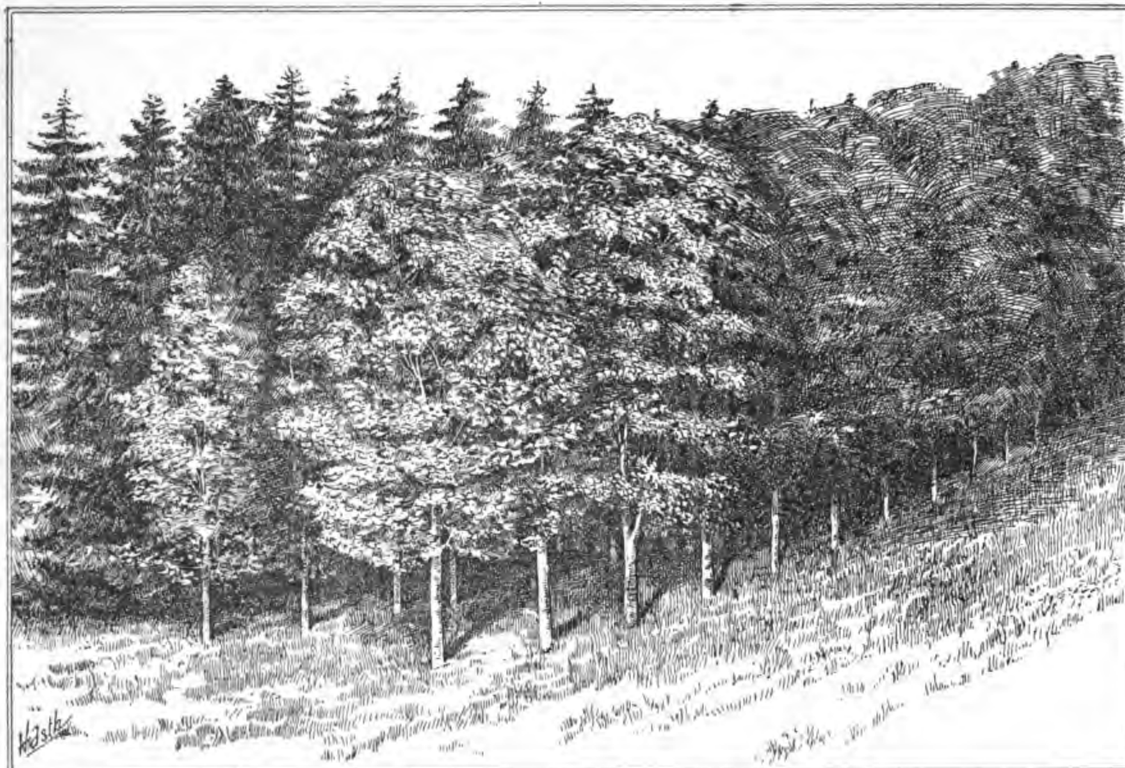

FIG 1.—*A model mixed Windbreak, fifteen years old.*

A STUDY OF WINDBREAKS IN THEIR RELATIONS TO FRUIT-GROWING.

I. INFLUENCES OF WINDBREAKS UPON FRUIT PLANTATIONS.

ALTHOUGH the best writers upon horticultural topics are nearly unanimous in recommending windbreaks for all fruit plantations, there is, nevertheless, wide difference in opinion and practice among good cultivators concerning them. Fruit-growers, as a rule, hold decided opinions concerning windbreaks. In fact, they usually hold extreme opinions, either wholly opposing shelter belts in all cases, or positively advocating them. All who are engaged in the growing of fruits or who attend fruit-growers' gatherings, have heard the most positive experiences cited in support of both opinions. There must be good reasons for these opposing views. No general studies of the subject appear to have been made, yet it is one of commanding importance in many directions. There appear to be no well-grounded maxims or precepts among growers themselves, and statements concerning the merits of shelter belts are commonly vague. Studies of temperatures as influenced by windbreaks are now being inaugurated at this station under excellent opportunities.

The present inquiry was undertaken about six months ago, and it is the outgrowth of previous experience and observation in the same direction. Many inquiries have been made and fruit farms have been visited. Three hundred circulars were addressed to leading fruit-growers in New York and Michigan, asking for definite information in regard to windbreaks. Seventy-seven replies were obtained. This is a large proportion, and the number may be assumed to include all the persons of the three hundred addressed, who have had experience, or have made direct observation. Forty-eight of these replies relate definite results. It is probable that nearly the whole range of experience with windbreaks in reference to fruit culture in the northeastern states is represented in these letters.

The present discussion is presented as follows :

I. Influences of Windbreaks upon Fruit Plantations.

II. Proper location of Windbreaks, and manner of making them. General Summary.

I.—Experiences Favorable to Windbreaks.

A. IN NEW YORK.

OBSERVER.	Site and Soil	Direction of Prevailing or severest winds.	Location in reference to large bodies of water.	Kinds of fruit grown.	Kind of Windbreak.	BENEFITS DERIVED.
Patrick Barry, *Rochester.*	Various.	W.N.	About 6 m. South Lake Ontario.	All kinds.	Norway spruce, European larch, and other evergreens.	"We regard windbreaks, in this country, as of vast importance, not only in fruit culture, but for the comfort of man and beast."
Irving Rouse, *Rochester.*	Same level as surrounding land. Clay.	N.	do	Apples.	Norway spruce, on Northwest.	Increased crop. Less loss from windfalls. No loss from severe cold.
J. Wentz, *Rochester.*	High, sandy loam.	W.	do	Plums.	Siberian arbor vitæ.	Good.
T. G. Yeomans & Sons, *Walworth.*	Undulating, strong, sandy loam.	W.	About 8 m. South Lake Ontario.	Apples, Dwf. Pears, Q'ncs, small fruits.	Norway spruce, mixed belts, and natural forest.	Prevent windfalls. Render orchards more uniformly productive and longer lived. Render labor easier.
W. T. Mann, *Barkers.*	Slightly rolling, clay and sandy loams.	W.SW. NW.	2 m. South of Lake Ontario.	General.	Row of Norway spruce on W., set 2 ft. apart in 1874	Fruits, especiallly pears and berries, have blossomed and ripened several days earlier near windbreak. Fewer windfalls. Retains snow for 10 to 15 rods from wdbk.
B. W. Clark, *Lockport.*	—— ——	SW.	About 10 m. S. L. Ontario	General.	Norway spruce, natural forest.	Good.
G. W. Dunn, *Pierce's.*	Same elevation as surrounding orch'ds. Loam.	W.	On Lake Ontario.	Apples.	Beechwood land.	Trees start earlier. Fruit hangs on longer. Winter apples more easily gathered.
C. P. Whitney, *Orleans.*	Very high ridge, W. slope. "Limestone."	W.N.	N. of Canandaigaa and Seneca Lakes—about 8 miles.	Apples, set in '73 and '74	Natural forest.	"I see no difference in the growth of trees, except that they stand straighter where they are protected."
V. B. Wheat, *Orleans.*	High, sandy loam, ranging to gravel.	W.N.	do	Grapes, Apples, Peaches	Natural forest.	"I am very certain that the protection from forest is beneficial in various ways."

S. C. Davis, *Medina*.	High. Clay and gravelly loam.	W.N.	About 10 m. So. L. Ont.	General.	Norway spruce.	Good.
E. B. Norris, *Sodus*.	Mostly high. Sand, grav. loam.	W.N.	On Lake Ontario.	Apples.	Norway spruce.	Good.
C. H. Perkins, *Newark*.	——— ———	W.	About 15 m. South Lake Ontario.	Small fruits, grapes quinces and peaches.	Norway spruce.	Protects from cold snaps; "no telling the good a windbreak will do."
W.G. Ellwanger, *Canandaigua*.	High.	W.	On Canandaigua Lake.	Orchard fruits & nursery st'k.	——— ———	Fewer windfalls. Prevents ground from freezing too deep and destroying nursery stock.
H. J. Peck, *Seneca Castle*.	E. and W. slope. Heavy loam.	W.	Midway bet. Canandaigua and Seneca Ls.	Apples, set in 1873.	Closely planted apple orchard on the west.	Fewer windfalls. Trees become more firmly rooted, and are more upright.
G. C. Snow, *Penn Yan*.	100 to 500 ft. elevation. Gravelly loam.	W.	About 6 miles. At north end of Keuka L.	Peaches, apples, grapes.	Natural forest on W. and S.W.	Fewer windfalls. Less liability to damage to fruit buds from cold. Retains snow and leaves.
C. W. Pierson, *Waterloo*.	Slightly higher than adjacent lands. Sdy loam.	W.N.	Bet. Cayuga and Sen. L.—about 5 m.	Peaches and apples.	Norway spruce hedge, kept cut back to 10 or 12 ft	"The result, I think, has been beneficial to the peach crop."
A. I. Hulett, *Elba*.	Gravelly loam.	W.SW.	About 20 m. south Lake Ontario.	Apples and pears.	Natural forest.	"Apples and pears so protected rarely fail, while others, on equally as good soil and exposed, fail one year out of three."
P. B. Crandall, *Ithaca*.	High.	W.	At south end of Cayuga Lake.	Peaches.	Farm buildings on north.	"Trees will blossom full this spring; in the field with no protection, buds have been mainly destroyed."
J. J. Thomas, *Union Springs*.	——— ———	W.	Near N.E. cor. of Cayuga Lake	Pears.	Double row of Norway spruce on west.	Trees near the windbreak less injured by cold winter winds.
Anthony Lamb, *Syracuse*.	Same level as adjacent lands. Clay l'm	W.N.	Near Onondaga Lake.	Nursery stock, grass and grain	Norway spruce.	Much less injury to nursery stock from cold.
E. A. Powell, *Syracuse*.	do	W.N.	do	Nursery stock, also gen'l crops	Norway spruce.	Protects nursery stock from effects of cold.
G. T. Powell, *Ghent*.	100 feet above adjacent lands. Gravelly loam.	W.N.	About 8 m. east of Hudson River.	Apples, pears, grapes and cherries.	Elms, maples and Norway spruce.	"Saves a large amount of fruit from being blown off." Holds snow. Lessens evaporation from the soil. Encourages birds.

2.—Definite Observations which Favor Windbreaks.

OBSERVER.	Site and Soil.	Direction of prevailing and severest winds.	Location in reference to large bodies of water.	Kinds of Fruit observed.	Kind of Windbreak observed.	BENEFITS OBSERVED.
O. J. Weeks, *West Webster*.	In general.	—— ——	Very near Lake Ontario.	Apples and pears.	Forests and artificial shelter belts.	Fewer windfalls; "some years, more than one-half the entire crop" blowing off in exposed orchards, while few blow off in those well protected.
D. Bogue, *Medina*.	Clay loam.	—— ——	About 10 m. S. of Lake Ontario.	Pears, apples, cherries and plums.	Norway spruce hedge.	Fewer windfalls.
W. C. Almy, *Dundee*.	In general.	N.W.	3 m. west of Seneca Lake	In general.	Natural timber.	"Where the wind is very severe, a windbreak on the north and west would be very valuable."
A. Hammond, *Geneva*.	In general.	N.W.	N. end of Seneca Lake	In general.	In general.	Fewer windfalls. High ground on the west is "quite important in many respects."
A. S. Dyckman, *S. Haven, Mich.*	High. Sandy.	W.SW.	On E. shore of L. Mich.	Peaches.	Evergreen hedge	Prevents the blowing off of snow and sand.
C. J. Monroe, *S. Haven, Mich.*	In general.	W.SW.	On E. shore of L. Mich.	General.	Street trees.	"If all our highways were bordered with good rows of trees, we should find much advantage from them."

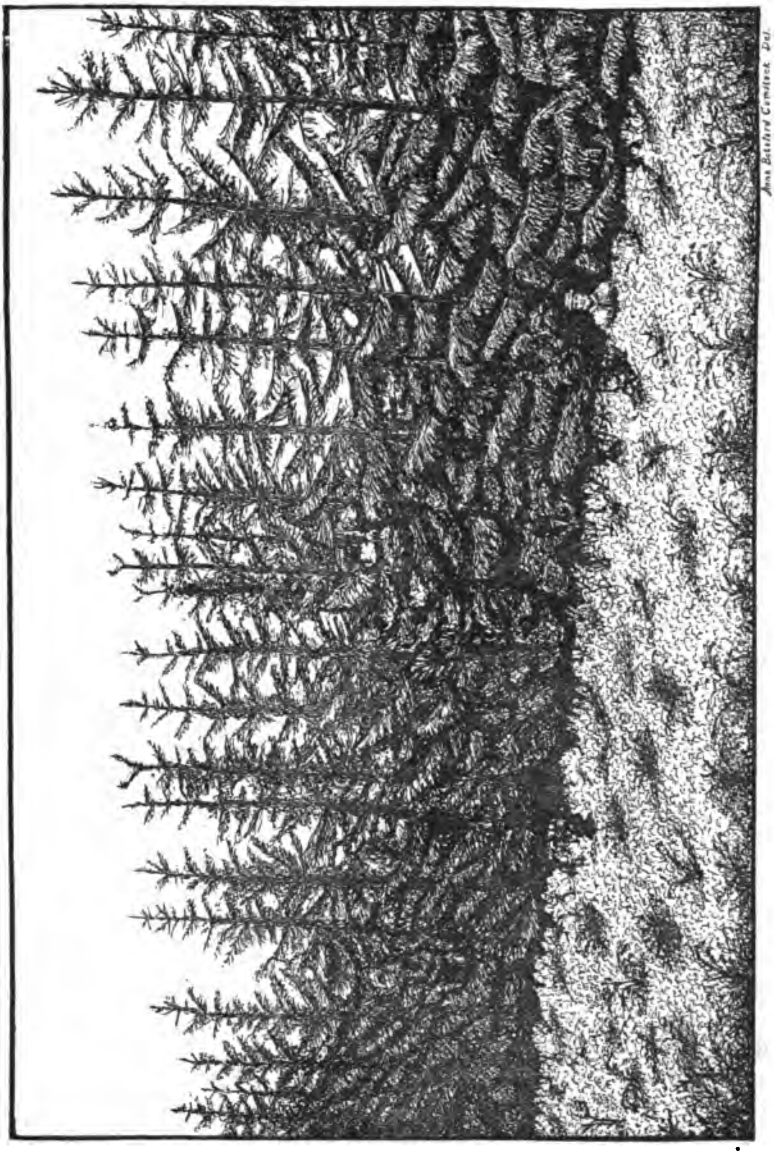

FIG. 2.—*A good Norway Spruce Windbreak, twenty-five years old.*

3.—Statements from Leading Authors.

It [the fruit garden] should be screened on the north and the east, either by high walls and fences, or, what is far better, either by hills or a deep and dense border of evergreen or other forest trees, intermixed with fruit trees and shrubs of ornament.—*Kenrick, New American Orchardist*, ix (1832).

As our native forests become cleared away the climate is changed and becomes more harsh; hence it is found desirable to construct some kind of protection from the point of most destructive harsh winds and storms. Belts of trees, either evergreen or diciduous, or both mixed, and surrounding or placed so as to screen from the northeast, north, and northwest, are considered highly advantageous.—*Downing, Fruits and Fruit Trees of America*, 54.

The atmospheric changes and conditions we cannot control, and we can modify them only in a very limited degree, by hedges, by timber belts, and by evergreen screens, the value of which begins to be appreciated.—*Warder, American Pomology*, 207.

In localities exposed to the sweep of winter winds, belts of evergreen or deciduous trees will be found of great service. In all instances where the side of an orchard, exposed to the prevailing winds, is less successful and productive than the opposite side, proof is afforded that shelter would be beneficial; belts, especially if of deciduous trees, standing too near fruit trees, have, however, rather injured than benefitted them. The orchard should be beyond the reach of their shade and roots, and be well exposed to sun and air.—*Thomas, Fruit Culturist, new ed.*, 48.

If possible, a situation should be chosen where some natural obstacle, as a hill, or a belt of woods, would break the force and influence of these destructive winds. Where no such obstacle naturally exists, a belt or border of rapidly growing trees * * * * should be planted simultaneously with the planting of the orchard. * * * Instances occur every year in our own section where sheltered orchards bear full crops, whilst those fully exposed to the winds fail entirely.—*Barry, Fruit Garden, new ed.*, 176.

Although having an orchard closely pent up by trees, etc., is injurious, nevertheless a screen of forest trees, at such distance from the fruit trees as that the latter will not be shaded by them, is of very great service in protecting the trees in spring from severe cold winds.—*Bridgeman, Gardener's Assistant, by Todd, II*. 39.

As the young wood and fruit buds [of the peach] often suffer from the piercing blasts of winter, a spot that is sheltered from these is much to be desired. And, as they usually come from the north and northwest, a site on the south or southeast of a wood or hill is, other things being equal, greatly to be preferred.—*Fulton, Peach Culture*, 68.

To shelter an orchard from the prevailing wind is often more important even than the aspect; for pear trees, especially when heavily laden with fruit and exposed to a wind storm, will suffer more injury from being

shaken than from an ordinary late frost. * * * The evergreens should be planted in lines parallel with the pear rows, and they will more than pay for the ground they occupy in protecting the fruit trees from heavy gales.—*Quinn*, *Pear Culture for Profit*, 19.

It is within the power of man greatly to modify the character of a situation by the judicious planting of belts of evergreens, by a wise addition of elements and a proper culture of the soil, and by encouraging the shade of the vineyard itself wherever circumstances indicate its necessity.—*Strong*, *Culture of the Grape*, 101.

In general, it will be found necessary to secure protection on the west, north, and northeast. * * * No defense is better than a good belt of Norway spruce, and if they form a crescent in which the vineyard is embowered, but little danger need be apprehended from violent winds.—*Phin*, *Open Air Grape Culture*, 40.

If the land has no protection from the north and northwest, see what the facilities are for supplying one either by walls or a belt of trees. If trees are to be used, evergreens are best.—*Fuller*, *Grape Culturist*, 89.

The location [for the vineyard] should be sheltered from the cold winds from the north and northwest.—*Husman*, *Culture of the Native Grape*, 43.

EPITOME OF BENEFITS DERIVED FROM A WINDBREAK,

Stated somewhat in order of importance.

1. A windbreak may protect the plantation from cold.
2. Reduces evaporation from the surface of the soil, tending to mitigate drought in summer, and root injury in winter.
3. Lessens windfalls.
4. Lessens the breaking of trees which are laden with fruit or ice.
5. Retains snow and leaves, thus tending to prevent deep freezing and excessive evaporation.
6. Facilitates labor in the fruit plantation.
7. Protects blossoms from severe winds.
8. Enables trees to grow straighter than if exposed.
9. Reduces injury from the drying of small fruits on the plants.
10. Holds the sand in certain sections.
11. Sometimes causes fruits to ripen earlier.
12. Encourages birds.
13. It can be made an ornament.

4.—Experiences Adverse to Windbreaks.

OBSERVER.	Site and Soil.	Direction of Prevailing and severest winds.	Location in reference to large bodies of water.	Kinds of fruit grown.	Kind of Windbreak.	INJURIES SUSTAINED.
H. M. Jaques, *Lockport.*	— —	SW.	About 10 m. So. L. Ont.	Apples and Pears.	Natural forest on North.	"Apples next the woods are poor color and very wormy."
S. D. Redman, *Newfane.*	Level. Gravelly loam.	W.SW.	Very near L. Ontario.	Quince.	Norway spruce hedge on E. W. and N.	"Have not been able to detect any difference in trees or fruit from those not so protected."
Julius Harris *Ridgeway.*	Sandy loam.	W.	About 5 m. South Lake Ontario.	Apples and Peaches.	Natural forest.	Next the windbreak, trees less thrifty and apples fall more and earlier.
Geo. Catchpole, *North Rose.*	Same level as adjoining land. Sandy and clay loam.	W.	Aoout 5 m. South Lake Ontario.	Apples and Peaches.	Natural forest on East, North, and West.	"The more windbreaks, rail fences, brush, and other matter, the more insects."
Oscar Weed, *North Rose.*	— —	W.	About 5 m. South Lake Ontario.	Apples.	Natural forest on West.	"The trees along the woods for several rows were more infested with worms than the balance of the orchard and bore less fruit."
C. H. Hess, *Castile.*	Somewhat elevated. S. and E. exposure. Gravelly loam.	W.NW.	Inland. About 4 m. S. of Silver Lake.	Apples.	Natural forest on North and North West.	"It has been very noticeable that the fruit grown on the part of the orchard toward the piece of woodland is always wormy, knotty, and inferior, never suitable for barrelling."
N. J. Edmunds, *Brockport.*	High. Sandy loam.	W.	About 10 m. South Lake Ontario.	Peaches and Apples.	Natural forest.	"The best results in both apples and peaches were where the trees were most exposed to the wind and sun, and the poorest within ten rods of the forest."
M. F. Varney, *North Collins.*	— —	SW.	About 8 m. East Lake Erie.	Grapes.	Natural forest.	"Have noticed some times that grapes do the best where the wind is least broken."
W.G. Ellwanger, *Canandaigua.*	High.	W.SW.	On Canandaigua Lake.	Peaches.	— —	"I find that for peacnes it is best to have no protection."

5.—Definite Observations Adverse to Windbreaks.

OBSERVER.	Site and Soil.	Direction of Prevailing and severest winds.	Location in reference to large bodies of water.	Kinds of fruit observed.	Kind of Windbreaks observed.	INJURIES OBSERVED.
W. Hopkins, *Lewiston.*	In general.	W.SW.	On Niagara R. about 8 m. So. L. Ont.	Apples and Peaches.	In general.	Fruit more wormy.
J. A. Root, *Skaneateles.*	In general.	—	On N. end of Skaneateles Lake.	In general.	In general.	"Late spring frosts do far more damage to grapes, peaches, etc., in a protected location than where the wind has free play."
A. S. Dyckman, *So. Haven, Mich.*	High. Sandy.	W.SW.	On E. shore of L. Mich.	Peaches.	Natural forest.	"More frosty."
Members of Grand R. Valley Hort. Society, *Grand Rapids, Mich.*	High. Gravelly.	W.	About 25 m. East of Lake Michigan.	Peaches.	In general.	"W. N. Cook, Chas. W. Garfield, S. M. Pearsall, and John Pailow were all agreed that windbreaks are not desirable, as a cold wave is likely to settle down on trees when immediately under the shelter, which those farthest away have escaped."
W. N. Cook, *Grand Rapids, Mich.*	In general.	W.	About 25 m. East of Lake Michigan.	Peaches.	In general.	"In the summer following the cold winter of 1872–3, I travelled over a large part of Kent and adjoining counties and closely observed the influence of windbreaks. Wherever peach trees were situated on the east side of such timber belts, they were all killed, and the Baldwin apple fared little better; while on exposed places of the same elevation the trees were alive and often bearing fruit. I saw several peach orchards with protecting thickets on the east, and they were uninjured."

J. A. Pearce, *Grand Rapids, Mich.*	High.		SW.	About 25 m. E. of Lake Michigan.	Peaches.		—	—	Trees killed by cold winters next the windbreak.
J. F. Fitzsimmons, *Hillsdale, Mich.*	—	—	SW.W. NW.	Inland.	—	—	Natural forest.		"Have known orchards protected by woods on NW. and W. to do well, and have known them to do equally well without protection. Do not believe that a single windbreak is of any advantage."

EPITOME OF INJURIES SUSTAINED IN CONSEQUENCE OF A WINDBREAK.

1. A windbreak may render a plantation colder at certain times.

2. Fruit immediately adjoining the windbreak is apt to be much injured by insects and diseases, and to be small and inferior in color.

3. Trees immediately adjoining the windbreak are often less thrifty than others.

4. There may be greater damage from late spring frosts in sheltered plantations.

FIG. 3.—*A Lombardy Poplar Screen, eleven years old, for the protection of a Peach orchard.*

REVIEW OF THE INFUENCES OF WINDBREAKS UPON FRUIT PLANTATIONS.

The benefits derived from windbreaks are numerous, positive in character, and appear to possess sufficient importance to warrant the strongest recommendations of horticultural writers. Yet the injuries occasionally sustained in consequence of shelter belts may be serious, for it is a well attested fact that trees sometimes suffer from cold in the immediate vicinity of a dense windbreak when they escape injury in other places. This fact is easily explained, however. The influence of a windbreak upon the temperatures of an adjacent plantation is governed by its position with reference to prevailing or severe winds. Of itself, wind probably exerts little or no influence upon temperature. It acquires the temperature of surfaces over which it passes. If these surfaces are colder than the given area, cold winds are the result, or if warmer, as a large body of water, the winds are warm. But wind often causes great injury to plants because of its acceleration of evaporation; and winds which are no colder than the given area, if comparatively dry, may consequently do great damage to fruit plantations. This is particularly true at certain times during the winter season. Land winds, being cold and dry, are therefore apt to be dangerous, while winds which traverse large bodies of water, and are therefore comparatively warm and moist, are usually in themselves protectors of tender plants. The following table, giving the average temperatures of different winds at New Haven, Connecticut, as compared with the mean temperature of that place, shows that those winds which blow off the Sound are much warmer than the land winds*:

Direction of wind.	Average above the mean temp.	Direction of wind.	Average under the mean temp.
Southwest, . .	+ 4°	Northeast, . .	— 0.6°
South, ...	+ 3.2°	West, ...	— 1.1°
Southwest, . .	+ 1.2°	North, ...	— 2.7°
East, ...	+ 0.5°	Northwest, . .	— 4.5°

* Loomis' Meteorology, 88.

The mitigating influence of bodies of water is familiar ; the following figures will serve to show the extent to which they modify the mean temperatures of the four coldest months† :

A.—IN NEW YORK.

STATIONS.	Dec.	Jan.	Feb.	Mar.	Average	Latitude.	Elevation.	Period of observation
Fredonia,	30.8	28.7	27.4	35.3	**30.55**	42.26°	709 ft.	1830–1848.
Rochester,	28.5	26.0	26.4	33.1	**28.5**	43.07°	506	1830; 1833–1853.
Auburn,	29.5	24.4	24.6	33.5	**28.0**	42.55°	650	1827–1849.
Utica,	26.8	23.3	23.4	32.3	**26.45**	43.06°	473	1826–1848.

B.—IN MICHIGAN.

STATIONS.	Dec.	Jan.	Feb.	Mar.	Average	Latitude.	Elevation.	Period of observation
Detroit,	26.9	27.0	26.6	35.4	**28.97**	42.20°	580 ft.	1836–1846; 1849–1851.
Fort Gratiot,	26.6	25.3	25.3	33.2	**27.6**	42.55°	598	1830–1846; 1849–1852.
Battle Creek,	27.0	24.1	22.6	33.7	**26.85**	42.20°	800	1849–1855.
Ann Arbor,	25.3	23.6	21.0	32.7	**25.65**	42.15°	700	1854–1855.

It will be seen that the warmest stations are in most intimate connection with large bodies of water : Fredonia is on Lake Erie, Rochester near Lake Ontario, Auburn near the Central New York lake region. and possibly within the influence of Lake Ontario, while Utica is farther inland. Similar observations might be made concerning the Michigan stations. Temperatures of the coldest days would show much greater differences.

It should be observed that the influence of a body of water is not governed by its proximitv, but by elevation of the land and direction of winds. Grand Rapids, Michigan, although about twenty-five miles from Lake Michigan, is greatly influenced by it.

It is evident that if a windbreak stops or deflects a warm wind, it may prove injurious. A still place in the lee of the windbreak may therefore be the coldest part of the plantation. So far as the

† Compiled from Blodget's Climatology of the United States, 38.

writer is able to learn, this sort of injury from windbreaks is confined to those regions which are directly influenced by bodies of water. The eastern shore of Lake Michigan has furnished many examples. Most growers in that region demand a free circulation of air from the lakeward, while desiring protection from the east. (Cf. Mr. Cook's letter in Table V.) This experience, however, does not argue that windbreaks should be entirely abolished on the lakeward sides of plantations, but that such breaks should be thin enough to allow of the passage of wind, while breaking its force. In such places, a windbreak should be what its name implies, a wind-break, not a wind-stop.

The advantages of windbreaks in lessening windfalls, and in preventing the breaking of trees do not appear to be sufficiently understood. In sections which are influenced by large bodies of water, or when the fruits grown are sufficiently hardy to endure the most trying winds, these are the chief advantages of shelter belts, and are ample reason for planting them. The greater facility with which labor can be performed in windy weather, under the protection of a windbreak, is worth consideration.

The injuries sustained through the greater abundance of insects immediately adjoining the windbreak, are easily overcome with the modern spraying devices. There are many instances in which the windbreak lessens the vigor of one or two adjoining rows of fruit trees, but such injury appears to occur only where cultivation is poor, or where the windbreak has already obtained a good foothold when the fruit is set. The writer has examined a number of excellent plantations this year in which the rows next the windbreak are as vigorous and productive as any in the orchard. In fact, a number of good observers declare that best fruit and greatest productiveness occur next the windbreak. Figures 2 and 3, show, respectively, thrifty raspberries and peaches next the windbreak.

The following, from T. G. Yeomans and Sons, Walworth, Wayne Co., New York, who have had extensive and pronounced experiences with windbreaks, is a judicious statement of the advantages to be derived from shelter belts :

"We have been extensively engaged in fruit culture for over forty years, and now have in bearing about 130 acres of apple orchard, 10 acres of dwarf pears, 10 of orange quince, and small fruits. For many years we have experimented with windbreaks, and now have many artificial shelter belts of various kinds and ages, the oldest having been planted nearly thirty years. We consider windbreaks to be of the greatest value to fruit culture, and we

are confident that most fruit-growers do not realize their importance. They protect the trees and plants at all seasons, and prevent windfalls to a great extent. Orchards thus protected in this region are more productive, more uniform, and longer lived than others. They render labor among the trees and plants much easier in windy days, and enable men to work in very windy weather, when otherwise it would be impossible. We have always succeeded in raising good fruit close to the windbreak. * * * We consider land devoted to shelter belts as very profitable investment, even to ordinary farm crops. We should not attempt to grow dwarf pears, orange quinces, or raspberries, without shelter of some sort."

II. PROPER LOCATION, AND MANNER OF MAKING WINDBREAKS.

1. THE LOCATION.

The answer to this printed question must vary greatly with circumstances, and with the kind of fruit. Some localities are greatly exposed to prevailing winds; others are screened by hills or sheltered in depressions and do not need screens. But our hardiest fruits are better off with some protection.—*J. J. Thomas, Union Springs.*

Where we have occupied grounds with a western exposure, we have usually planted lines of Norway Spruce on the western border. * * * How to avoid the severity of the west winds has been a constant study with us. *Patrick Barry, Rochester.*

Wherever the orchards or small fruit plantations would otherwise be exposed to strong winds.—*W. T. Mann, Barker's.*

Where the wind has a sweep of a mile or more.—*B. W. Clark, Lockport.*

Under all circumstances with which we are acquainted. Peach trees should not be planted nearer than 5 rods from a dense windbreak, or the drifting snow will break them down. Apple trees may be planted some nearer.—*Geo. W. Dunn, Pierce's.*

Should plant windbreaks for all fruits except apples. No telling the good a windbreak will do.—*C. H. Perkins, Newark.*

Where there is a long exposure to west and southwest winds. *A. I. Hulett, Rochester.*

Under all circumstances where ground is exposed to severe winds. *Irving Rouse, Rochester.*

In all bleak locations; also to a moderate extent as ornaments and for general protection.—*S. C. Davis, Medina.*

Where an orchard has a northern and western exposure. *E. B. Norris, Sodus.*

1st. Where it is impossible to get a good exposure; 2d, where fruit is planted which is especially liable to loss from wind, as King apples or Duchess pears.—*H. J. Peck, Seneca Castle.*

Upon a site that is exposed to a cold and bleak north or west wind.—*C. W. Pierson, Waterloo.*

Where orchards and fruit plantations are so situated as to be exposed to cold bleak winds; in fact, in all exposed places I have no doubt windbreaks are very beneficial.—*Anthony Lamb, Syracuse.*

On all elevated, exposed locations, in order to hold the snow more evenly over the land and to prevent the evaporation that takes place rapidly with a high wind. Also to furnish nesting places for birds.—*Geo. T. Powell, Ghent.*

In all windy places.—*D. Bogue, Medina.*

Where the wind is very severe, a windbreak on the north and west would be very beneficial.—*Wm. C. Almy, Dundee.*

In exposed places where sandy ridges are liable to blow away.—*A. S. Dyckman, South Haven, Mich.*

I would set nut-bearing trees on the north and west of all fruit orchards, for protection and for the nuts.—*S. M. Pearsall, Grand Rapids, Mich.*

Where the snow blows off.—*Geo. C McClatchie, Ludington, Mich.*

I would recommend them wherever land is exposed to raking winds, first, for retaining snows on the ground, second, to protect fruit from winds.—*J. F. Taylor, Douglas, Mich.*

In my situation, I should want the windbreak some 40 to 80 rods from the orchard on the west, and extend to the north. Do not think it would be safe to plant one close upon the west side of my orchard for fear of still air settling down over the break.—*H. H. Hayes, Talmadge, Mich.*

For all small fruits especially, for all soils and localities.—*J. N. Stearns, Kalamazoo, Mich.*

Where the land slopes to the prevailing wind. Should want it only high and thick enough to break the force of the wind, not to produce a dead calm.—*R. J. Coryell, Jonesville, Mich.*

In all exposed situations.—*L. D. Watkins, Manchester, Mich.*

Would plant my hedge on the side where most exposed to high winds.—*J. Austin Scott, Ann Arbor, Mich.*

Wherever the grounds are exposed to the south and west winds.—*D. G. Edmiston, Adrian, Mich.*

Epitome.—It appears that a windbreak is desirable wherever the fruit plantation is exposed to strong winds. In order to prevent possible injury from too little circulation of air in certain localities, particular care should be exercised in the construction of the windbreak (cf. next section). The west, southwest, and north winds are the ones which need greatest attention in general.

2. CHARACTER OF A GOOD WINDBREAK.

We have usually planted lines of Norway Spruce on the western border. Sometimes a line of European larch is planted with the spruce. These and the Scotch and Austrian and white pine are all good for windbreaks.—*Patrick Barry, Rochester.*

Evergreens are certainly preferable to deciduous trees. Judging from observation, Norway spruce in single row planted two feet apart is best.—*W. F. Mann, Barkers.*

We should recommend the Norway spruce planted in a single row from six to eight feet apart, or set four feet apart and every other one removed in a few years. If the location is much exposed, we would recommend a row or two of maples on the windward, set from eight to ten feet apart in the row, the rows being from ten to fourteen feet apart.—*T. G. Yeomans and Sons, Walworth.*

The best kind I ever used or saw was a good Norway spruce hedge set

close enough together to make a tight break, and trimmed back until they had formed a tight hedge at least ten feet high.—*E. B. Norris, Sodus.*

I do not believe that a solid windbreak would be desirable, as a circulation of air is necessary. We need only to break the power and force of the wind.—*Geo. T. Powell, Ghent.*

Evergreens,—Norway spruce, Austrian pine, Scotch pine, etc.,—planted in wide belts and not to close, but irregularly, something like nature.—*A. Hammond, Geneva.*

Something tall but not too thick, that will allow a free passage of wind but moderate its force. I have some faith in Lombardy poplar trees for this purpose.—*A. S. Dyckman, South Haven, Mich.*

Norway spruce every time, set four feet apart. Keep well sheared, and you can have a perfect hedge as high as 20 or even 30 feet.—*J. Austin Scott, Ann Arbor, Mich.*

Epitome.—From a general study of the subject, it appears that in interior localities dense plantings are advisable, tight hedges being often recommended. In localities influenced by bodies of water, however, it is evidently better practice to plant a belt simply for the purpose of breaking or checking the force of the warmer winds, still allowing them to pass in their course. Such a belt gives the desired shelter to trees when laden with fruit and ice, and may hold the snow, while danger from comparatively still air is averted. The damage from still air is usually observed in the lee of natural forests, and it is in such places that injury is reported by Michigan correspondents. The writer has found no indisputable evidence to show that such injury ever accompanies artificial windbreaks; places where such injury was reported have been visited, but the loss of trees and fruit was plainly due to age of trees or other obvious reasons. Still, it is probable that a hedge-like windbreak may sometimes be the cause of mischief.

The coarser evergreens, planted close together, are therefore advisable for interior places, while deciduous trees, or evergreens somewhat scattered, are often better for the lake regions. In these latter cases, however, the lay of the land is important, for if atmospheric drainage is good there is less danger of injury from tight belts. Lower levels, upon which cold air settles, are therefore more in need of open belts than higher lands. For interior places, a strip of natural forest is the ideal windbreak. In artificial belts, the kind recommended by Messrs. Yeomans, and illustrated in Fig. 1, is undoubtedly one of the best. The illustration shows two rows of maples backing up a row of Norway spruce. "The maples then receive and break the force of the wind and prevent the spruces from becoming ragged. We never shear the spruces."

Our correspondents have advised the following trees for shelter belts :

	Recommended by		*Recommended by*
Norway spruce,	25 persons.	Hemlock spruce,	1 person.
Austrian pine,	5 "	Arbor vitæ,	1 "
Scotch pine,	3 "	Nut bearing trees,	1 "
White pine,	2 "	Hard maple,	1 "
Native deciduous trees,	2 "	Elm,	1 "
Lombardy poplar,	2 "	Basswood,	1 "
European larch,	1 "	Willows,	1 "

GENERAL SUMMARY.

1. A windbreak may exert great influence upon a fruit plantation.

2. The benefits derived from windbreaks are the following : protection from cold ; lessening of evaporation from soil and plants ; lessening of windfalls ; lessening of liability to mechanical injury of trees ; retention of snow and leaves ; facilitating of labor ; protection of blossoms from severe winds ; enabling trees to grow more erect ; lessening of injury from the drying up of small fruits ; retention of sand in certain localities ; hastening of maturity of fruits in some cases ; encouragement of birds ; ornamentation.

3. The injuries sustained from windbreaks are as follows : Preventing the free circulation of warm winds and consequent exposure to cold ; injuries from insects and fungous diseases ; injuries from the encroachment of the windbreak itself ; increased liability to late spring frosts in rare cases.

a. The injury from cold, still air is usually confined to those localities which are directly influenced by large bodies of water, and which are protected by forest belts. It can be avoided by planting thin belts.

b. The injury from insects can be averted by spraying with arsenical poisons.

c. The injury from the encroachment of the windbreak may be averted, in part at least, by good cultivation and by planting the fruit simultaneously with the belt.

4. Windbreaks are advantageous wherever fruit plantations are exposed to strong winds.

5. In interior places, dense or broad belts, of two or more rows of trees, are desirable, while within the influence of large bodies of water thin or narrow belts, comprising but a row or two, are usually preferable.

6. The best trees for windbreaks in the northeastern states are Norway spruce, and Austrian and Scotch pines, among the evergreens. Among deciduous trees, most of the rapidly growing native species are useful. A mixed plantation, with the hardiest and most vigorous deciduous trees on the windward, is probably the ideal artificial shelter belt.

L. H. BAILEY.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

HORTICULTURAL DEPARTMENT.

X.

OCTOBER, 1889.

Tomatoes.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

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Agricultural Experiment Station.

BOARD OF CONTROL:

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin for friends, will send us the names of the parties.

Cornell University Experiment Station,
Ithaca, N. Y.

PLATE I.

IGNOTUM.—Two-thirds natural size.

	IV.	V.	Wheat Bran (83 analyses)
Moisture	12.37	12.22	12.28
Ash	4.26	5.42	3.78
Crude Fat	3.73	4.40	5.70
Crude Protein	11.31	13.81	15.07
Crude Fibre	8.44	7.38	8.71
N. free Extract	59.89	56.77	54.26
	100.00	100.00	100.00
Cost	$10.00	$80.00	——
Valuation	14.10	15.00	$16.35

(The above valuation is calculated by taking three-fourths of the German values established by Wolff. It is to be understood that these values are only comparative, and do not represent the market price or feeding value.)

Remarks:

IV. This bran is of fair quality, and is low in cost.

V. This is one of the many foods which claim to improve the digestion, increase appetite, etc. It is composed of wheat bran, or shorts, mixed with a little salt, and a small quantity of some aromatic plant. Whether it is economical to use this food, depends largely on the scarcity of wheat bran and salt. These are much cheaper unmixed in this locality. No experiments proving the value of fenugreek, anise, etc., have been tried, to my knowledge, and the small amount mixed with the bran can be purchased separately and mixed with the food, if deemed advisable. I have never seen any patented food of this character which has proved economical for cattle feeding.

SOOT.

A sample of soot, sent to the station for analysis, contained 1.13 per cent. of nitrogen. The value of soot as a top-dressing depends not so much on its value as a fertilizer, as on the fact that it helps the soil to absorb heat.

Persons sending samples for analysis to this Experiment Station are advised to send a letter, giving such data in regard to the sample as will help decide whether the matter is one of public utility or not. Unless this is done, it will be classed as work for private parties, and no analysis for private parties will be made by the Station. Analyses having a value for the public will be made free of charge, but, with the present working force, no analysis of any commercial fertilizer can be made, except those fertilizers used by the Station.

W. P. CUTTER.

BOTANICAL DEPARTMENT.

NOTES ON THE MEADOW-GRASSES.

The term meadow-grass as here used is a general one and is intended to include the various species of the botanical genus *Poa*, of which the best known representative is the Kentucky Blue Grass, or June Grass.

The genus Poa is one of the largest genera of grasses, the most conservative authorities making out at least from 80 to 100 species. These are widely dispersed over the northern temperate regions, but are infrequently met with in warmer latitudes. Within the limits of the State of New York about twelve meadow-grasses are found growing wild as native or introduced plants, while the number in the United States is not far from forty-five.

Of all this large number only a very few are regarded as possessing any agricultural value ; but it is probable that other forms if subjected to cultivation might prove valuable for certain soils or certain purposes.

The notes here given on a few meadow-grasses are derived from experiments now in progress on a considerable number of grasses which are commonly regarded as possessing greater or less value as cultivated plants. The experiments include the cultivation of the grasses in question both in pots and in the open ground, and are intended to afford opportunities for a somewhat close economic, structural, and comparative study of the species in question.

The part of the experiment here referred to consists of the sowing of the seeds of some thirty agricultural grasses in adjacent plats in the garden, where the soil and all conditions of cultivation are as nearly uniform as possible. The plats are each two by six feet in size, and were sown in May 1889, the seeds being obtained in the open market from a commercial dealer. The experiments are under the immediate charge of Mr. W. W. Rowlee. The notes here given are made Nov. 20, 1889.

1. Kentucky Blue-grass. June-grass. Spear-grass. (*Poa pratensis.*) Three plats were sown, the seeds being obtained from different sources,—*a*, an extra quality of seed, direct from Kentucky,

obtained through a seed house in Ithaca; *b*, from a seed house in New York City, which furnished also samples of all the kinds of seeds used in the experiment; *c*, common commercial seed obtained in Ithaca. Plats *a* and *b* are completely covered with an abundant growth of grass, from which a considerable cutting could now be made. Plat *c* is only about half covered. None of the plats have seeded except very sparingly.

2. Wire-grass. Blue-grass. (*Poa compressa.*) Only about half the ground is covered, and the plants are growing in rather large separate stools. The plants blossomed and fruited freely. Old seed stalks are still abundant.

3. Fowl Meadow-grass. False Red-top. (*Poa serotina.*) The plot is well seeded, fully ninety per cent of the ground being covered. Flowered and seeded freely, the old stalks being still abundant, as in the last.

4. Rough Meadow-grass. (*Poa trivialis.*) The plat is poorly seeded, not more than half covered. The seed was poor and obviously in part untrue to name.

5. Wood Meadow-grass. (*Poa nemoralis.*) A few plants, apparently true to name.

6. Water Meadow-grass. (*Poa aquatica.*) Only a few plants, and these of uncertain identity.

The notes here given indicate the great difficulty of obtaining a satisfactory seeding with commercial grass seed, especially as regards those kinds less generally in use. The field experiments here noted correspond in all important respects with pot experiments in the green house; but the results of the whole series of experiments will be hereafter more carefully and fully elaborated.

ON ROOT-PROPAGATION OF CANADA THISTLE.

A considerable study of the Canada thistle has been made during the past season with reference to its power of propagating itself both by seeds and by under-ground roots. The study is still in progress, but it may be worth while to note at this time some of the results of experiments on root-propagation.

A number of plants were dug from a field of sandy soil, April 11, 1889. At this time the young plants had begun to grow, the leaves being from one to two inches in length. From the roots two sets of cuttings were made, the first, marked A in the table,

from the smallest thread-like roots which could be found ; the other marked B, from stouter roots from one-eight to one-fourth of an inch in diameter.

The length of the cuttings varied from one-sixteenth to one inch in length. They were planted in pots and placed in the cool house April 12. The results of the experiment are in part indicated in the following table :

Experiment Number.	Size of Cutting.	Length of Cutting in Inches.	No. of Cuttings Sown.	Number of Plants.
1.	A	$\frac{1}{16}$	72	0
3.	A	¼	72	0
6.	A	1	24	1
7.	B	$\frac{1}{16}$	36	0
9.	B	¼	36	5
10.	B	½	24	24

As a general result of the experiments it may be inferred that minute fragments of the roots of Canada thistle, when left in the soil are not likely to grow, while very small portions of roots of a somewhat larger size are pretty sure to produce new plants freely. It should be noted, however, that the soil in which the cuttings were placed was almost constantly too damp—a condition which could not well be avoided for reasons not necessary to mention here; so that the inference may fairly be drawn that the results above recorded do not show the full power of the Canada thistle to multiply itself by root-propagation.

ON THE VITALITY OF WEED SEEDS.

During the season of 1879 a considerable collection of seeds of various weed plants were made for the Botanical Department, the special purpose of which was to aid in naming such seeds or plants as might be sent for identification. As a part of a general study during the past season of the physiology of weed plants, a number of these seeds were tested as to their vitality. The collection was kept in the Botanical Museum, the seeds being corked up in small bottles. The conditions were not favorable to the preservation of the vitality of the seeds, as the museum was almost always hot and dry, especially in the winter, when constantly steam heated.

Thirty-two kinds of seeds, (or in the case of the wild carrot,

the seed-like fruits) were chosen for the experiment. These were sown in boxes in the green house, April 13, 1889, and as noted above were all ten years old. Out of the thirty-two kinds sown, only ten germinated up to the end of the experiment, May 30, as shown in the following table :

Department Number.	Kind of Seed.	No. of Seeds Sown.	Date of Harvest.	Number of Plants.
3	Pigweed. Green Amaranth. (Amaranthus albus). .	50	Apr. 22	24
10	Thyme-leaved Sandwort. (Arenaria serpyllifolia) .	50	Apr. 22	26
13	Pursl'ane. (Portulaca oleracea).	50	Apr. 22	15
15	Carrot. (Daucus carota)	40	May 30	15
23	Narrow-leaved Plantain. (Plantago lanceolata) . .	50	Apr. 22	23
29	Pigweed. (Chenopodium album).	50	May 30	25
30	Red-root. Pigweed. (Amaranthus retroflexus). . .	50	Apr. 22	25
31	Dock. (Rumex—species not known)	50	Apr. 22	16

It should be noted that the conditions for germination in the green house were probably not so favorable as in an out-door seed bed, as the atmosphere was constantly near the point of saturation and the soil for the most part too moist.

In the following table the kinds of seeds of which no germination took place are given :

Tall Buttercup. (Ranunculus acris.)
Wild Parsnip. (Pastinaca sativa.)
Alyssum. (Alyssum calycinum.)
Shepherd's-purse. (Capsella Bursa-pastoris.)
St. John's-wort. (Hypericum perforatum.)
Soapwort. (Saponaria officinalis.)
Catchfly. (Silene noctiflora.)
Cockle. (Lychnis Githago.)
Chickweed. (Stellaria media,)
Mouse-ear Chickweed. (Cerastium viscosum.)
Sweet Clover. (Melilotus alba.)
Caraway. (Carum carui.)
Cone-flower. (Rudbeckia hirta.)
Dandelion. (Taraxacum dens-leonis.)
Salsify. (Tragopogon porrifolius.)
Plantain. (Plantago major.)
Toad-flax. (Linaria vulgaris.)
Speedwell. (Veronica arvensis.)
Wheat-thief. Red-root. (Lithospermum arvenss.)
Gromwell. (Lithospermum officinale.)
Hound's-Tongue. (Cynoglossum officinale.)
Sheep-sorrel. (Rumex acetosella.)

The plants indicated in table I were allowed to grow until they were from two to four inches in height. All appeared strong and vigorous as though quite capable of asserting their rights had they begun their career in field or garden.

A. N. PRENTISS.

CRYPTOGAMIC BOTANY.

[The following notes on subjects now under investigation in the Cryptogamic Laboratory, are contributed chiefly for the purpose of soliciting information from those practically acquainted with them in the field or garden. Any facts relative to the extent of the disease, the history of its appearance, favoring conditions for its development, its treatment, successful or unsuccessful, will be welcomed.—W. R. DUDLEY, Dec. 1889.]

I.—THE ONION MOLD.

Peronospora Schleideniana, De Bary.

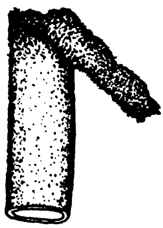

Fig. I.—Leaf of Onion, (natural size,) showing the mold (*Peronospora Schleideniana*) on the upper part.

So far as we can certainly ascertain this destructive disease was observed in New York last year, for the first time. It was forwarded to us from Madison, N. Y. by Mr. R. A. Goodrich, on July 29, who writes, * * * "It is very destructive. I have a bed of onions in my garden the tops of which are now all dead and dry from the effects of this parasite. It first appeared last year but has not become general in this section. The plant is killed by the time the bulbs are from one-half to one inch in diameter. In setting out this spring the small onions saved from last year's crops I found several of the bulbs completely covered by this mold and threw them away. It shows that the mold can be kept over winter." On August 6th, he writes: "very little of it can be found at present. The season of its growth seems to be the months of June and July."

About this time it was observed by ourselves on the onions in the gardens on the University farm, where it was not particularly destructive, rarely causing half a leaf to wither, or attacking all the leaves. Several small fields of the crop were noticed in Ithaca, all of which were unaffected by the mold.

It is common and greatly dreaded in Europe; but was not noticed in America till 1883, when observed by Professor Trelease* in Wisconsin. Since then it has not often been mentioned and seems to have been largely confined to the West. Even in the Connecticut River Valley, the only disease of the Onion attracting attention appears to be the "Onion Smut" (*Urocystis Cepulae*, Frost.)

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*In the "First Ann. Rep. of the Agr. Exper. Sta. of the Univ. of Wisc." (1883) this author summarizes what was known concerning the Onion Mold or "Onion Rust," and gives the best account of it, available to American gardeners.

The mold first appears on the upper part of a leaf as a velvety grayish outgrowth, being visible to the unaided eye, (Fig. 1). This pilose appearance is due to the fruiting branches, or conidiophores, growing out of the stomates, (Fig. 2) from the mycelium in the interior of the leaf. The stomates are numerous and in many plants each one is occupied by a fruiting branch, hence the velvet-like aspect of the diseased part. The gray or smoky tint is due to the lavender color in the cell-wall of the conidial spore, (Fig. 2, co.) The direct effect of the fungus is to cause the upper part of the leaf to become pallid, slowly shrivel, and finally in the autumn to become nearly white.

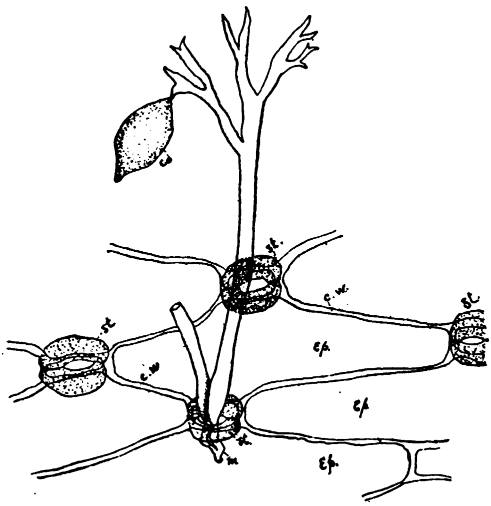

Fig. 2.—A few epidermal cells (ep.), and Stomates (st.) of the Onion. A conidiophore of the Mold growing through a stomate from the mycelium (m.) bears a conidium (co.) The cell-walls (c. w.)

This *Peronospora* is nearly related botanically to several destructive forms of fungi such as the Downy Mildew of the Grape, the Lettuce Mold and the more destructive Potato Rot fungus. Its habit is similar. Its conidial spores germinate within a few hours after maturity if they fall on the surface of the onion-leaf and find it moist. The germ tube enters a "breathing-pore" or stomate when it forms an extensively branching and ramifying mycelium, running among and preying upon the leaf-cells. A few days suffice for its maturity when its conidiophores, already mentioned, grow through the stomates and immediately develop the conidia on the ends of the ultimate branches as shown in the figure. The rapid maturing of these conidia furnish another crop of spores for fresh infections.

The rapid and the fatal progress of the disease as indicated in the letter from Mr. Goodrich, is thus accounted for. If it has not already, in many quarters, been as severe as at Madison, where it destroyed the crop, it is likely to develop at any time into a dan-

gerous enemy, if we may judge from the experience in England and France.

An important link in its history, its mode of passing the winter, has not been definitely ascertained. Beside the conidial spores, which are ephemeral, it produces rarely "oospores," or spores which will live over winter in the dead tissues of the onion-leaf. But these are probably not the active propagators of the disease. They rather ensure the species against complete extinction at any time.

Mr. Goodrich and others have found the onion bulbs in the spring affected, apparently by this fungus. We have examined the tissue of fresh leaves growing on diseased plants in October and November, and found vigorous mycelium among the cells, although there was no external sign of the fungus, nor was there any disposition to send out fruiting branches when the onion plant was brought into a warm room. If the mycelium hibernates in the leaves or bulbs and begins to fruit in the spring from this source, it is possible our future observations may ascertain the fact.

No remedy has been tried. But the success in France of the copper fungicides in the treatment of a related parasite, the Potato-rot,—(see repetition of this important experiment, appended below), justify us in hoping they will protect the onion also. No bulbs from a crop diseased the previous year should be set out; and the English are in the habit of sowing the onion seed in the fall, thus enabling the young plant to get a good start before the possible advent of the fungus in the spring.

NOTE: THE PREVENTION OF POTATO ROT.

Col. A. W. Pearson of Vineland, N. J., in "Garden and Forest" Dec. 4, 1889, reports almost completely successful experiments during 1889, against the common Potato Rot (*Phytophthora infestans*) by the use of either of the following copper solutions:

(1). *The Bordeaux Mixture.* The particular formula employed was as follows: (a) Sulphate of copper (pulv.), 6 pounds, in 4 gallons of hot water, (b) Fresh Lime, 4 pounds in 4 gallons of cold water. Mix (a) and (b) slowly and thoroughly and dilute to 22 gallons.

(2). *Ammonia Solution of Copper.* (a) Carbonate of copper, 3 oz, (b) Ammonia liq., 1 quart. Dissolve (a) in (b) and dilute to 22 gallons.

He reports experimenting on two plats of Peach-blow Potatoes, growing side by side, under the same conditions, and equal in

area. The fungus and consequently the disease appeared on the unsprayed plat. He obtained only 164 pounds of small unmarketable tubers of poor flavor. The disease did not appear on the sprayed plat on leaves or tubers; and 346 pounds of large tubers of fine flavor were produced.

II.—*ANTHRACNOSE OF CURRANTS.

******Gloeosporium* *Ribis*, (Lib.), Mont. and Desm.**

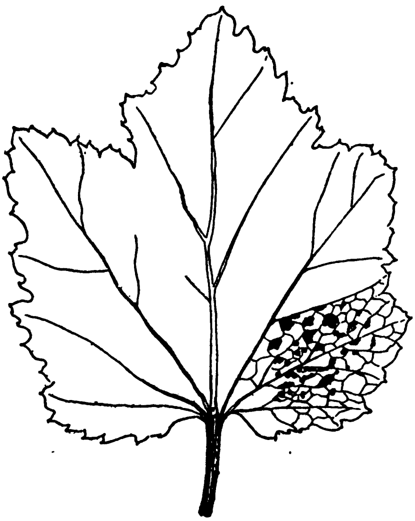

Fig. 3.—Leaf (reduced ½) from the White Dutch Currant. The venation shown in detail on the right hand together with the Leaf-blight, (*Gloeosporium Ribis*).

This note is published, on what is apparently a comparatively new trouble in the garden, to call attention to it, and afford information that would seem important at the present time, although it will appear that our knowledge is meager enough. Investigations on it begun last summer, will be continued during the coming season.

The spots appear (Fig. 3) chiefly on the upper surface but within the tissues of the leaves of certain species of the wild currant, and certain varieties of cultivated species. It was first reported from Amcrica by the Rev. M. J. Berkeley in "Notices of North Amer. Fungi" Grevillea II, p. 83, (Dec., 1873). It is there given as occurring in Connecticut on leaves of *Ribes nigrum*,—a cultivated currant,—collected by Charles Wright, and in "New England, by Russell." Since then it has been found by Dr. C. H. Peck, on leaves of the Wild Fetid Currant (*R. prostratum*.) It was found abundantly the past season on the leaves of the White Dutch currant growing in the University garden, while the Black Naples and the Crandall (*Ribes aureum*) growing next the White

*The common spotting of bean-pods, a disease of the Grape, one of Raspberry and Blackberry leaves and other diseases are caused by various species of *Gloeosporium*. Mycologists are adopting the name Anthracnose for all *Gloeosporium* diseases, hence the above name.

Dutch were free. Mr. C. M. Booth of Rochester reported it as severely attacking the Red Dutch Currant. Dr. C. H. Peck the State Botanist, reports it as abundant on and injurious to cultivated currants near Albany. All agree as to its effects. It appears in June or the early part of July, as small dark brown or blackish spots from ¼—1 millimeter in diameter. (Fig. 3). These may increase rapidly; and as the epidermis is raised by the spores beneath these spots, it becomes whitish, and a small pore appears in this raised surface through which the spores (Fig. 4) held together by a mucilage, escape in a little tendril. On account of the whitened epidermis the spots incline to a rustier or grayer tint than they possess at an earlier date. The general color of that part of the leaf infested by the fungus at this stage is a dull brown. The leaves soon turn yellow, begin falling before the middle of July, and by the first or second week in August, if not earlier, the bushes are as bare as in November. Mr. Booth says that "under such circumstances the currants do not fully ripen but shrivel and fall off."

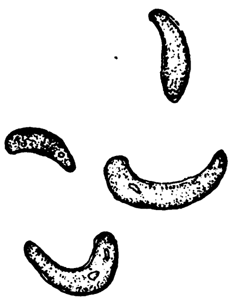

Fig. 4.—Spores of *Glœosporium Ribis.*

The spores (Fig. 4) are one-celled, curved, somewhat enlarged at one end, and, in all North American forms reported, from 1½–2 times the length of the European forms described by Saccardo. The measurements given by Berkeley, Peck and those made by ourselves practically agree, being from .015—.025 millimeters in length. Specimens from France in Roumeguere's *Fungi Gallici* No. 1873 are from .012—.016 millimeters long, and M. C. Cooke sent Ellis* specimens from Europe which were mostly .015 m. m. long, while Saccardo in his great work† gives only .010 of a m.m. as the length. There seems little doubt therefore of the identity of the American and the European forms, nevertheless the disease seems to have done little injury in Europe, and until this year, not to have attracted any attention whatever in America.

It is to be hoped that the peculiarly moist summer gave it an advantage it will not soon have in succeeding years, but it may be necessary to carefully watch the varieties susceptible to it, next June, and to apply occasionally by means of a fine sprayer, like the Eureka Sprayer, one of the copper solutions; for the entrance

*Ellis and Everhart, *Journal of Mycology* I, p. 110.
‡Sylloge Fungorum III, p. 706.

of the spores into the leaf must be *prevented* if the crop is to be protected. It is fair to suppose the copper solutions will be as efficacious in this as in Strawberry Leaf-blight.

The biological investigation of this presents peculiar difficulties, for we have little doubt that it hibernates elsewhere than on the fallen leaves of the previous season.

III. LEAF-BLIGHT OF QUINCE AND PEAR.

Entomosporium maculatum, Lev.

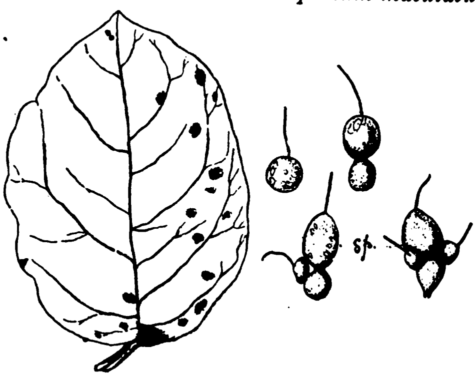

Fig. 5.—Leaf of Quince with spots of *Entomosporium maculatum*; also the spores (sp), of the latter much magnified. E. PORTER, Del.

Five years ago Mr. G. F. Wilcox of Fairport, N. Y., sent to the University, Quince leaves and fruits very much diseased by the above. The leaves were affected by circular brown spots from 1–3 millimeters in diameter, and the fruits had many brown patches from 3–7 millimeters in diameter on the surface. At the centre of the diseased areas in both cases were small perithecia (or pseudo-perithecia) containing the insect-like spores (fig. 5, sp.) of this fungus, and arising from the mycelium growing among the cells. These areas on the fruit were slightly sunken as if a finger had been pressed on them. Many of the fruits badly affected had cracked and all were unmarketable. We reported it as *Morthiera Mespilii*, Fuckel; *var. Cydoniae*, Cooke and Ellis, the name by which it was usually known at that time. Saccardo has revived the earlier name *Entomosporium maculatum*, Lev., which is given in his *Sylloge Fungorum*, III, p. 657, and by which it is now usually mentioned.

For some years it has been scarce on the Quince although it was abundant this year in some localities in New York.

It affects the Pear in precisely the same way, causing the leaves to fall and the fruit to crack. The greatest injury, however, is caused by its attack on seedling pears or quinces in the nursery. By causing the fall of the leaf the parasite so weakens the standard that grafting will not succeed.

Fortunately experiments during the past two years have proven—so we are assured on good authority, that this disease in all its phases, can be entirely controlled by the use of the copper solutions.* No nurseryman or fruit-grower need suffer further loss therefore, if he sprays the leaves once in two or three weeks in the early part of the growing season, and is careful to renew the spraying after heavy showers.

Considerable has been written concerning the habits of this parasite. It is believed to be chiefly reproduced through its conidia, (the spores figured in this paper), but Sorauer † claims to have discovered perithecia with ascospores or resting spores, on old leaves late in the autumn ; such, however, have not been reported in America. Indeed there are many hidden facts connected with the hibernation of this fungus, and the sources of its infection in the spring, which if known may lead to precautionary care such as may save time and money to the fruit-grower. One of the students in this laboratory is now at work on this question, has contributed the drawing (No. 5) would be glad to correspond on the subject, and will publish the results of the work if new facts are developed.

The CLOVER RUST [*Uromyces Trifolii*, (Alb. and Schwein.) Wint.] is another recent arrival from the Old World, and has destroyed a great amount of the host-plant this season. If correspondents can furnish us with well-considered estimates of the injuries caused in different localities or the history of its appearance, such facts may prove of value to us in investigations now going on.

W. R. DUDLEY.

ENTOMOLOGICAL DEPARTMENT.

THE APPLE-TREE TENT CATERPILLAR.

Clisiocampa americana.

During the last few years the orchards in many parts of this State have become overrun by the Apple-tree Tent-caterpillar. In certain sections this insect has increased to so great an extent that it has destroyed every leaf in the orchards. Although the habits of this insect have been well known to entomologists for

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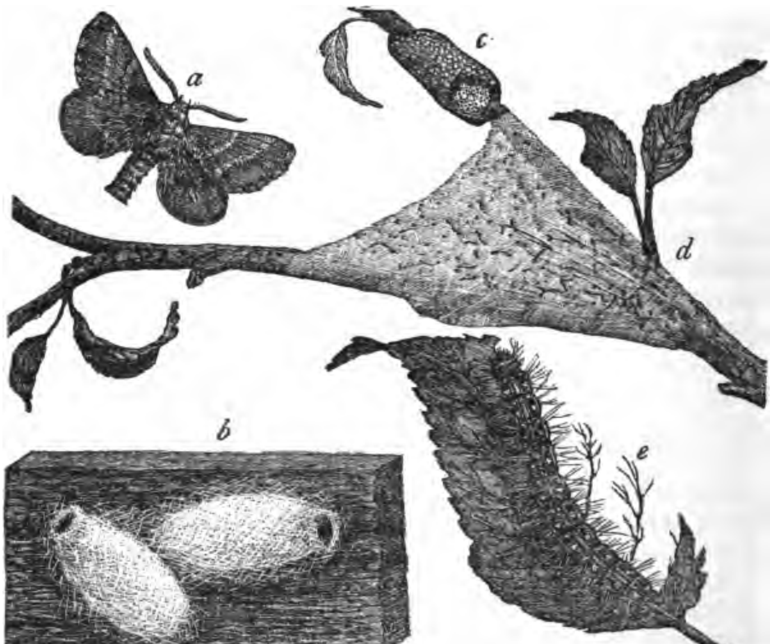
* See *Garden and Forest* Dec. 4, 1889, p. 582.

† Pflanzenkrankheiten Ed. II., Vol. II, p. 371. Plate XVI.

many years, it is evidently worth while to give a brief account of it in this place ; for it is rapidly assuming the importance of a first class pest. This, however, is unnecessary as it is one of the easiest of insects to combat.

We have two very common insects that build their webs in fruit and forests trees. One of these makes its webs early in the spring chiefly in apple and wild cherry trees ; the other occurs in the latter part of the summer, and infests a much wider range of trees ; frequently occurring in large numbers upon ash, oak, and other forest trees, as well as fruit trees. The former of these is the Apple-tree Tent-caterpillar (*Clisiocampa americana*) ; the latter, the Fall Web-worm (*Hyphantria cunea*) I do not care to speak further in this place of the latter. I merely mention it in order that the Apple-tree Tent-caterpillar shall not be confounded with it.



The accompanying figure illustrates the transformations of the Apple-tree Tent-caterpillar. The eggs are shown at c ; these are laid in a ring-like cluster about a small twig, and are covered with a substance, which protects them from the weather. These

eggs are laid in mid-summer, and remain upon the trees until the following spring. They may, therefore, be found at any time during the winter months. This fact indicates an excellent method of combating this pest. If the trees are carefully searched during that part of the year when they are bare of foliage, the clusters of eggs can be easily found and destroyed. The little machine resembling a pair of shears, attached to the end of a long pole which is used for picking apples, will be found very useful in collecting these clusters of eggs. By the use of it one will be saved the necessity of climbing the trees. All wild cherry trees occurring in the vicinity of the orchard should also be cleared of eggs or destroyed; as these usually serve as breeding places for this pest.

Early in the spring just as the buds are beginning to open the eggs hatch. In many cases this happens before the buds open; and the young caterpillars are forced to gnaw into the buds in order to get food. In this way there is frequently much injury done before the webs appear. For this reason, I earnestly advocate the destruction of the egg clusters in preference to fighting the insects at a later stage.

As soon as the caterpillars hatch they move down the twig until they reach another branch; and here in the fork they begin their web. The beginning of such a web is represented at d, in the figure just below the cluster of eggs. Ordinarily, however, the caterpillars move a much greater distance than that represented, making their web in a much larger fork. This web serves as a nest for the entire colony of worms hatched from the cluster of eggs. As the worms increase in size they add successive layers to the outside of the nest, making it larger and larger, until it becomes one or two feet or more in length.

A point to be remembered is that this web serves merely as a residence, and that the worms must leave it in order to get their food. Thus during a portion of the day comparatively few caterpillars will be found in the nest, the majority of them being scattered over the tree, feeding upon the foliage. It is a curious fact that this caterpillar spins a silken thread wherever it goes. As a result of this, there may be found upon the limbs over which the caterpillars pass in going to and from their nest, little bands of silk, extending from their nest to the various parts of the tree where the insects have fed.

As these webs are very conspicuous, the ordinary method of

fighting this insect is by the destruction of it in the webs. This can be easily done by means of a torch attached to the end of a long pole. Care should be taken to do this when the insects are in the web, and not while they are scattered over the tree feeding. Ordinarily the best time will be early in the morning, or late in the afternoon, or during a stormy day. This work should also be done early in the season very soon after the appearance of the leaves; in fact as soon as the webs can be seen. It is a good deal like locking the stable after the horse is stolen, to delay the destruction of these insects until they are nearly or quite fully grown, as is usually done, if done at all. The caterpillars reach maturity about the middle of June. A single mature caterpillar is represented at e, in the figure. At this time they leave the trees in search of a place in which to spin their cocoons; they may then be seen crawling in all directions upon fences and over the ground. They choose some secluded place as the lower side of a stone or other object, where each makes for itself a dense silken cocoon. Two of these cocoons are represented attached to a piece of wood at b, in the figure. These cocoons may be easily recognized by their having a yellowish-white powder mixed with the silk.

Within the cocoon the insect changes to a pupa, and remains in this state about three weeks; it then emerges as a brownish moth whose wings are crossed by two oblique whitish lines. This moth is represented at a, in the figure. Soon after the adults appear the females lay their eggs, thus completing the circle of transformations.

There remains to be mentioned one other method of fighting this insect; that is by spraying the trees, as soon as the leaves appear, with Paris-green water. In this way the caterpillars will be poisoned while feeding upon the leaves. If the Apple-tree Tent-caterpillar is the only insect to be fought in the orchard, I do not think the spraying of the trees will be found as cheap a method as the destruction of the webs, except in those cases where the insect is very abundant. Ordinarily there will not be more than one or two webs upon a tree; and those can be destroyed much more quickly and cheaply than the tree can be sprayed. But if the trees are to be sprayed for the Codlin-moth or the Canker-worm, the same application will serve to destroy the Tent-caterpillar.

JOHN HENRY COMSTOCK.

AGRICULTURAL DEPARTMENT.

FIELD TRIALS WITH FERTILIZERS.

Ever since the Station was established in 1879, more or less work has been done in the way of field trials with commercial fertilizers and the almost universal experience has been that no marked results have immediately followed the application of such manures especially phosphates. As the result of these trials and the common experience of farmers in the locality, it seems reasonable to assume that some peculiarity of the soil in a certain limited district renders the soluble phosphoric acid almost immediately inert so that the plant can not use it. That this phosphate is finally available to the plant seems almost as certain to us as that the plant cannot use it immediately.

In the season of 1888 three separate trials with fertilizers other than phosphates were made on widely different localities of the farm and on different crops. The results in general were much the same as previous experience had led us to expect with phosphates and are given herewith, simply for what they are worth with no attempt at generalization.

The crops were ensilage corn, clover and timothy mixed, and oats. In all cases four h indred pounds per acre of the fertilizer was used broadcasted, in the case of the corn and oats befere seeding and in the case of the grass, on the sod early in the spring. The plots were in all cases one-tenth acre in area and ranged side by side.

Fertilizer Used.	Ensilage Corn. Pounds per acre.	Clover and Timothy Hay—lbs. per acre.	Oats.	
			Grain. Bushels per acre.	Straw. Pounds per acre.
1. Nothing	†20610	*5445	*42⅜	*1945
2. Ground Bone	17100	*6010	42 3/16	1750
3. Cotton Seed Meal	15450	*5450	46⅞	2000
4. Cotton Seed Hull Ashes . . .	13900	*5255	46	2030
5. Star Bone Phosphate			48¾	2040
6. Equal parts of 3 and 4 . . .	13600			
7. " " 2 and 3 . . .	13200			
8. " " 2 and 4 . . .	14730			
9. " " 2, 3, and 4 . .		5690		
10. " " 2, 3, 4, and 5.			41	1990

* Average of Duplicate plots.

† Yield probably greater from moister situation of plot.

If we rearrange this table so that the yield of the unfertilized plot is in each case represented by 100 and the yields of the other plots changed in the same proportion it is easier to compare the effect of the fertilizers on the different crops. This we have done in the table below.

FERTILIZER USED.	Ensilage Corn.	Clover and Timothy Hay	OATS. Grain.	OATS. Straw.	Average
1. Nothing	100.	100.	100.	100.	100.
2. Ground Bone	83.	110.4	99.6	90.	96.1
3. Cotton Seed Meal	75.	100.1	110.7	102.8	94.
4. Cotton Seed Hull Ashes .	67.4	97.	108.5	104.4	90.3
5. Star Bone Phosphate . . .			115.1	104.8	
6. Equal parts of 3 and 4. . .	66.				
7. " " 2 and 3. . .	64.				
8. " " 2 and 4. . .	71.4				
9. " " 2, 3, and 4 .		104.5			
10. " " 2, 3, 4, and 5			96.7	102.3	

It will be seen that the average results obtained from those fertilizers that were used on all the crops is slightly below the crops obtained without the use of fertilizer. Even if we eliminate the effect of the moister situation of the unfertilized corn plot it could scarcely be claimed that there was an appreciable advantage gained by the use of the fertilizers.

A POINT IN THE CULTIVATION OF ROOT CROPS.

That roots form a very desirable adjunct to the winter ration of almost all kinds of domestic animals few who have raised them will question. At the same time from the large amount of water they contain, it is imperative that they be raised at the smallest possible cost in order to make their use profitable as a food for animals.

Two things make the growth of mangels expensive. First, germination is imperfect, in the second place, beside being imperfect, germination is often slow to start and being slow the weeds get the start of the young beets thus necessitating much hand weeding and a large increase in expense. These two things deter many who would otherwise raise considerable quantities from attempting their culture at all.

The mistake that is commonly made and to which we especially desire to call attention in this note is that beets are usually planted entirely too late. The common practice being to fit and plant the root ground after the corn is out of the way. As the result of ex-

perience we have come to the conclusion that this is not the best practice. The beet is a plant native to much colder latitudes than is corn and will germinate and grow in temperatures where corn would do nothing. The root ground should be plowed and fitted as early in the spring as the land can be brought into proper condition for the seed ; that is deep, rich, mellow and finely pulverized. At this time there is seldom a lack of sufficient moisture in the soil to insure rapid and even germination of the seed, while if planting is delayed till the latter part of May an incipient drought is often responsible for the slow start of the beets.

By planting early (about the middle of April), by the use of plenty of seed that is known to be good, and with the least possible amount of hand cultivation, we have succeeded in raising roots at a cost so low that we believe they can be fed at a profit.

The results of the past season's crop are fairly typical of our usual success and are given herewith not as representing anything unusual in the way of yield but as illustrative of what may be expected with ordinary careful practice.

The land was clover sod and had received a coat of farm yard manure in its regular rotation. It was plowed and fitted with harrow and cultivator till there was a seed bed such as the one described. The beets were planted April 18th. The season was very wet and the weeds were unusually numerous thus necessitating more than the usual amount of hand weeding. The plot contained 36,853 square feet or a little more than three-fourths of an acre. The yield and labor expended were as follows :

361.75 hours labor, man at 15 cents	$54.26
76 hours labor, team at 20 cents	15.20
Seed 3 pounds at 50 cents	1.50
Total	$70.96
Yield from 36,853 sq. ft., pounds	60705
Yield per acre, pounds	71753
Yield per acre, bushels	1196
Yield per acre, tons	35.75
Cost per bushel for seed and labor	$.07

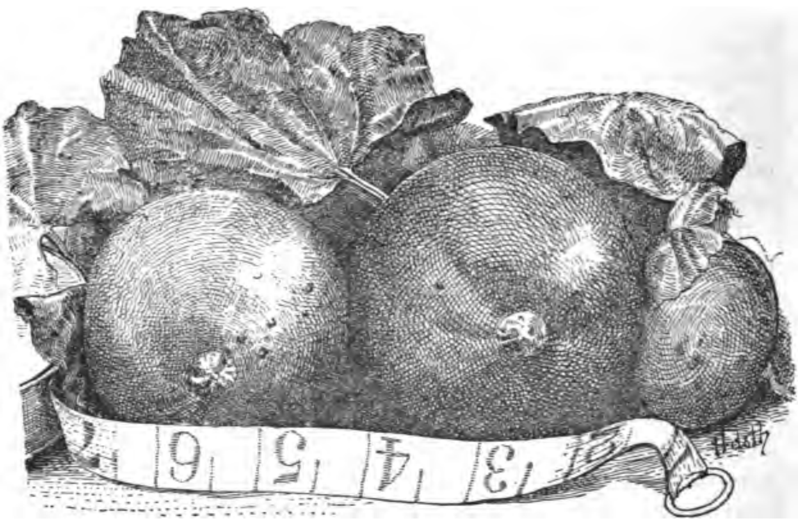
Good authorities, (*i. e.*, practical dairymen) consider roots to be worth ten cents per bushel for feeding purposes, when fed in small quantities as an adjunct, digester, or appetizer.

It will be noticed that we have charged for labor of man and team nearly double what they can be procured for on ordinary farms. Even at these prices we have succeeded in more favorable years in raising roots at a cost of five cents per bushel for seed and labor.

I. P. ROBERTS.

HORTICULTURAL DEPARTMENT.

THE ORANGE MELON.



The fruit to which I have given the name Orange Melon has been offered by several seedsmen and others during the last two or three years under a variety of names, as Vine Peach, Mango Melon, Vegetable Orange and Melon Apple. The descriptions of it are always more or less indefinite, and the cuts are such as to convey little idea of its relationships. The following description is a sample: "One of the most beautiful vegetables grown. They grow on vines same as melons, are a beautiful golden yellow, almost exactly resembling oranges in color, shape and size. The flesh is snow white. Fried as egg plant, when green, they are delicious, and most excellent for mangoes. They will keep in good condition two months after being picked."

This vegetable is a variety of the musk-melon species, *Cucumis Melo*. Several similar varieties of the melon are grown in Europe. and it will probably not be difficult to identify our plant with

some European variety during the coming season. The introduction of the Orange Melon into this country appears to have been recent. It was evidently first offered to the trade by Frank Finch, of Clyde, N. Y., probably four or five years ago. Mr. Finch writes, "I first obtained a sample of the vegetable orange from one of my customers. * * * I offered it to the trade, and now most of the seedsmen have it. I do not know how it originated." W. W. Tracy, of Detroit, informs me that "the vine peach and its nearly related Queen Ann's Pocket Melon are grown quite commonly by the Swedes, Norwegians and Danes in the northwest, and I think that the plants have been distributed from this source."

The Orange Melon is somewhat variable in size and shape. It is commonly nearly spherical, if one may judge from descriptions, but plants from one source gave us oblong fruits. The fruits range from two to three inches in diameter. They possess none of the common characteristics of the musk-melon fruit, but are suggestive, rather, of a cucumber. The variety presents some desirable features, but it is over praised.

THE CRANDALL CURRANT.

The Crandall currant was introduced but a couple of years ago, yet it has attracted general notice from the fact that it represents a species practically new to the fruit garden. The originator supposed it to be a hybrid between the Buffalo or Missouri currant and the common red currant.

Fifty plants were set upon the Experiment Station grounds in the spring of 1888. The plants have grown vigorously and all bore fruit last season. Plants have been observed in other places, also, and full notes and careful tests have been made.*

The Crandall is a simple variation of the Buffalo or Missouri currant (*Ribes aureum*), known in yards as the "flowering currant." It gives no indication of hybridity. The species is well known to be a variable one, and bushes occassionly appear which

* The writer published a full account of the variety in the American Garden, Sept. 1889, 309.

produce edible and attractive fruits. It does not appear to be a well "fixed" variety. Some of our bushes produce berries little larger than those of the red currant, while others give fruits five-eighths of an inch in diameter. It is also variable in period of ripening on our plants, although the soil is uniform throughout the row.

Our bushes were fairly productive, but a heavy crop could not be expected from young plants. Bearing canes and photographs from Frank Ford & Son, the introducers, show remarkable productiveness. The habit of the plants indicate probable high productiveness.

The plant is hardy and vigorous and so far our specimens have been free from insect attacks, although the currant worm was very abundant upon adjacent rows of common sorts. The bushes attain to a large size, and need more room than other currants.

The fruits are large and fair, bluish-black and polished. They separate from the stem and are therefore picked and sold singly, like gooseberries and cherries. The flavor is sweet and agreeable, though not pronounced. There is none of the grossness of flavor characteristic of common black currants. It makes good stews, pies, and jellies, whether used green or ripe. In jelly we prefer it to other currants.

The variety is wholly distinct from every other. It represents a new type of small fruit, which, when further selected and improved, must come to be a staple.

INFLUENCE OF SOIL UPON PEAS.

It is well known that peas are quickly influenced by certain soils. The fact was incidentally well illustrated in our garden the past season in a planting of the Golden Gem. The rows began in a good rich loam and ran into a stiff and strong clay. A good sod had been turned under a few days before the peas were sown. The ends of the rows were so dissimilar at picking time that they appeared to be planted with different varieties. Twelve average plants were selected from each end of the patch, and they gave the following data:

Plants on loam.—Average height of plant, 18 inches; average number of pods per plant, 5.4; all the pods, except sometimes the very uppermost ones, were ripe and there were no flowers.

Plants on clay.—Vines larger, deeper green, more glaucous (more "bloom"), with a tendency, not apparent in the other case, to produce two pods on a peduncle; average number of pods per plant, 7; only about two-thirds of the pods were ripe, and there were still some flowers.

THE INFLUENCE OF DEPTH OF TRANSPLANTING UPON THE HEADING OF CABBAGES.

It is a common practice among gardeners to set cabbage plants to the depth of the first leaf, upon the supposition that deeply set plants give better heads than others. The experience and observation of the writer, during several seasons, have lead him to doubt the greater efficiency of deep-planting, beyond some influence it may exert by preventing injury from very dry weather. The following tests were made during the past season, the soil, particularly in the case of the late cabbages, being poor or in poor condition. Heavy rains may have interfered with the experiments with the early sorts by packing the earth or washing it away from the stems. But the tests were carefully made, and the late plantings did not suffer from rains. The early cabbages were started in a forcing-house March 15th. The late ones were sown July 2nd. The deeply set cabbages were planted up to the seed-leaves, while the others were set at the same depth at which they stood in the seed-bed. The column marked "Ratio" is designed to show, graphically, the ratios between the average weights of head in each lot; the lightest average weight in every couplet is called 1, and the heaviest average weight is divided by it.

VARIETIES. *Early Sowing.*	Number of Heads.	Heaviest Head. Lbs.	Lightest Head. Lbs.	Average Weight. Lbs.	No. of Immature Heads	Ratio.
Vandergaw—Shallow.	22	8.5	1.2	4.8	3	1.4
Deep . .	20	6.	.4	3.3	6	1.
Salzer—*S's Lightning*						
Shallow. . .	26	5.5	1.	2.9	2	1.
Deep.	21	6.	1.5	3.9	0	1.3
Early Etampes—						
Shallow. . . .	19	4.5	.7	2.6	1	1.
Deep.	19	5.5	1.2	3 3		1.3
Early Jersey Wakefl'd						
Shallow. . . .	16	7.	.4	4.1	1	1.4
Deep.	12	4.	.9	3.	4	1.
Extra Early Express.						
Shallow. . . .	15	4.5	1.7	2.6	. .	1.
Deep.	15	4.5	2.3	3.3	. .	1.2
Early Winningstadt—						
Shallow. . . .	13	5.9	1.8	4.	. .	. .
Deep.	19	5.	2.2	3.9	. .	. .
All Seasons—						
Shallow. . . .	13	. .	. .	5.9	. .	1.1
Deep.	13	. .	. .	5.1	. .	1.
Hard Heading Red—						
Shallow. . . .	20	5.5	1.6	4.	0	1.1
Deep.	24	8.	2.6	3.7		1.
"Imp. Stone-Head Heavy Red Dutch."						
Shallow. . . .	20	10.5	3.7	7.	. .	1.06
Deep.	17	9.	4.	6.6	. .	1.
Wick's Long Isl. Red.						
Shallow. . . .	21	7.5	2 6	4.6	. .	1.
Deep.	11	7.5	3.9	5.6	. .	1.2
Late Sowing.						
Marblehead Mamm'th						
Shallow. . . .	24	7.	.5	2.2	18	1.
Deep.	26	5.	.5	2.9	8	1.3
Flat Dutch—Shallow.	30	9.	1.7	4.9	2	1.
Deep. .	34	10 5	.7	6.4	1	1.3
All Seasons—Shallow.	31	8.5	1.4	4.3	4	1.4
Deep. .	24	6.	.8	3.1	5	1.

Summary.—Of the twelve lots, one-half did best from each treatment. The comparative ratios are 13.46 to 13.6, in favor of deep plantings. In other words, in 565 heads, those from the deep plantings averaged about two ounces per head heavier. 270 cabbages gave better results in shallow planting, and 295 better in deep planting. The differences is the two cases are so slight as appear to be indifferent.

INFLUENCE OF DEPTH OF SOWING UPON SEED TESTS.

Extremes in depth of planting are known to greatly affect germination. The investigation here recorded was undertaken for the purpose of determining if minor variations in depth of planting exert any influence upon results of seed tests. Seventy-two tests were made upon tomatoes, one-half of the seeds in each test being sown one-fourth inch deep, and half one-half inch deep. They were all sown in the house during March and April, in potting soil in 22-inch flats. The figures of these tests are too extended for presentation here. The average total germination from the samples sown one-half inch deep was 87.07%, and from those sown one-fourth inch, 86.92%. The difference is only three-twentieths of one per cent. As a rule, plants appeared sooner from the ¼ inch samples, as might be expected. In some cases, however, the ½ inch samples gave the earliest visible results, probably because the soil, in these instances, was more uniformly moist at the greater depth. The general behavior of seeds at these depths, as regards rapidity of appearing, is shown in the following test of cauliflower seeds:

CAULIFLOWER; *Thorburn's Gilt-Edge Snowball.*—Thorburn.

125 seeds in potting soil in 22-inch flat.

No. 1, ¼ inch deep. No. 2, ½ inch deep.

SOWN APR. 4.

SAMPLES.	SPROUTINGS.								Total.	Per Cent.
	Apr. 8	9	10	11	12	13	14	15		
No. 1, ¼-inch . . .	36	37	12	4	1	1	. .	1	92	73.6
No. 2, ½-inch . . .	7	61	11	8	3	3	1	1	95	76.

Essentially the same results were observed in the case of the Green Flageolet Beans.

From the foregoing figures and remarks we may conclude as follows:

1. In tomatoes, there is no evidence that per cent. of germination is influenced by variations from one-fourth to one-half inch in total depth of planting; and there is indication that the same may be said of other plants.

2. The greater rapidity of appearing of the plants in ¼ inch plantings as compared with ½ inch plantings, is only such as is due to the fact that in the shallower plantings there is less soil for the plantlet to push through.

DO OLD SEEDS OF CUCURBITS GIVE SHORTER VINES THAN RECENT SEEDS?

There is a belief that new or fresh seeds of squashes, pumpkins, and melons produce plants which "run to vine" more that those from old seeds; and this supposed redundance of vegetation is considered to exist at the expense of fruitfulness. An extensive test was made upon this point last season. The following species and varieties were grown: Squashes: White Bush Scallop, 3 ages, Summer Crookneck, 2 ages. Watermelons: Peerless, 2 ages, Mountain Sprout, 4 ages, Black Spanish, 3 ages. Muskmelons: Nutmeg, 3 ages, Improved Canteloupe, 2 ages. Cucumbers: Long Green, 4 ages, Short Green, 3 ages, Early Chester, 2 ages. The age of the seeds ranged from one to six years. About 450 plants were grown, all of which were measured, including the laterals, and records were made of the numbers and weights of fruits. The plantation occupied a poor piece of land, with no other enrichment than a thin sod which was plowed under. The land had not been cropped for some years, and was therefore uniform in character, and well adapted to the experiment. The figures are much too extended to be presented here.

There was no evidence whatever that older seeds give shorter and more productive vines. In fact, there was no uniformity of behavior between seeds of like ages. The largest vines in some in-

stances came from oldest seeds, in others from the newest, and in others from those of intermediate ages. All this variation is evidently due to heredity of the individual seeds, or to conditions of growth of the immediate parents, rather than to age of seeds. The following summary of figures obtained from cucumbers may be taken as an indication of results in other species:

VARIETY.	Year when the Seeds were grown.	No. of Plants Raised.	Average Length of Vine, with Branches.	Ratios.
Long Green	1883	20	10.1	1.11
	1884	15	9.1	1.
	1886	13	17.1	1.88
	1888	13	14.1	1.55
Short Green	1884	3	25.7	1.52
	1886	4	17.5	1.03
	1888	14	16.9	1.
Early Cluster.	1882	10	8.7	1.
	1888	12	13.8	1.58

The ratios in the last column are obtained by taking the shortest average growth as 1, and dividing the other averages in the same variety by this number. In the first variety, Long Green, the shortest vines grew from 1884 seed and the longest from 1886 seed. In the Short Green, the shortest growth was from the most recent seed and the longest from the oldest seed, while in the Early Cluster the result is reversed.

TESTS OF A PATENT GERMINATOR.

A "New Preserver and Germinator of Cereals and Seeds of All Kinds," through the use of which there are to be "no more short crops" and which gives "absolute assurance of perfect and complete germination and an increase in yield of more than twenty-five per cent.," is sent out by F. P. Dimpfel, 60 Broadway, New York. The compound is evidently organic. It is apparently designed primarily for use upon cereals, but in virtue of the fact that it is adapted to "seeds of all kinds," it was tried upon vari-

ous garden seeds. The material is dissolved in water and used as follows:

"Pour the liquid on the seed 24 hours before using, stirring occasionally to assure the uniform saturation.

"It can also be used by immersion. Let the seed soak for 12 hours in the liquid and then take it out and allow it to dry."

This appears to mean that 24 hours treatment is required if the liquid is poured upon the seeds, while but 12 hours is required when the seeds are dropped into the liquid.

The following tests were made:

1. TURNIP, *Red Tcp Strap-Leaf.*—Thorburn.

No. 1, 100 seeds soaked in germinator 24 hours.
No. 2, same, in water 24 hours.

SOWN APR. 30.

SAMPLES.	May. 2	May. 3	May. 4	May. 5	May. 6	May. 7	May. 8	May. 9	Total.
1. In Germinator, 24 hours.	. .	20	33	13	5	3	2	4	**80**
2. In Water, 24 hours.	1	63	14	3	3	1	. .	. .	**85**

Epitome.—The sample treated with the compound gave slightly lower results than the other, and the germination was less rapid.

2. RADISH, *Early Scarlet Globe.*—Henderson.

100 seeds of each number.
No. 1, soaked in germinator 12 hours.
No. 2, soaked in water 12 hours.
No. 3, soaked in germinator 24 hours.
No. 4, soaked in water 24 hours.

SOWN APR. 27.

SAMPLES.	APR.		MAY.													Total.
	29	30	1	2	3	4	5	6	7	8	9	10	11	12	17	
1. Germinator, 12 hours .	.	.	2	1	.	2	1	4	8	3	1	.	2	.	.	**24**
2. Water, 12 hours	9	40	22	5	1	1	1	1	.	.	.	.	.	.	.	**80**
3. Germinator, 24 hours .	.	.	.	.	.	.	1	.	.	.	.	1	2	.	3	**7**
4. Water, 24 hours	.	13	44	11	4	5	2	1	.	.	1	.	1	.	.	**82**

Epitome.—The germinator so far weakened the seeds as to practically destroy their value, particularly in the sample soaked

24 hours, according to directions. The test was repeated, the seeds being soaked 6 hours :—

3. RADISH, *Early Scarlet Globe.*—Henderson.

No. 1, soaked in germinator 6 hours.
No. 2, soaked in water 6 hours.
No. 3, untreated.

SOWN MAY 3.

SAMPLES.	MAY.											Total.
	6	7	8	9	10	11	12	13	14	15	16	
1. Germinator, 6 hours	.	4	4	15	3	5	5	2	4	2	5	**49**
2. Water, 6 hours	2	58	4	7	.	.	1	.	.	.	.	**72**
3. Untreated	5	56	3	5	.	1	1	.	.	.	.	**71**

Epitome.—The seeds treated to germinator still gave poor results, yet they did much better than the samples soaked twice and four times as long ; they also germinated more slowly than the other samples.

4. ONION, *Red Wethersfield.*—Thorburn.

No. 1, 100 seeds soaked in germinator 24 hours.
No. 2, 100 seeds soaked in water 24 hours.

SOWN APR. 30.

SAMPLES.	MAY.								Total.
	3	4	5	6	7	8	9	10	
1. Germinator, 24 hours .	2	7	46	7	4	. .	. .	. .	**66**
2. Water, 24 hours	3	21	30	11	2	2	1	1	**71**

Epitome.—Seeds treated to germinator fell slightly below the other in per cent. of sprouting.

5. TOMATO, *Bell.*—Cornish.

No. 1, 100 seeds soaked in germinator 24 hours.
No. 2, 100 seeds soaked in water 24 hours.

SOWN MAY 2.

SAMPLES.	MAY.					Total.
	7	8	9	10	11	
1. Germinator, 24 hours	. .	55	33	4	2	**94**
2. Water, 24 hours	15	73	4	1	. .	**93**

Epitome.—The results are essentially the same in both samples. The test was repeated, giving 98 per cent. for the germinator and 89 per cent. for those soaked in water.

Conclusion.—With the exception of an indication of a trifling advantage in the tomato seed tests, in which the results may have been wholly accidental to the treatments, the germinator gave no results in germination superior to those obtained from soaking the same length of time in water; while in radishes the damage done by the material was marked. In radishes and turnips it also lessened the rapidity of germination.

L. H. BAILEY.

APPENDIX II.

Detailed statement of the receipts and expenditures of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30, 1889.

RECEIPTS.

FROM AGRICULTURAL DEPARTMENT.

1888.		
Nov. 6.	Wool sold,	$ 10 60
1889.		
Feb. 23.	Sheep Carcasses and Pelts,	5 40
Apr. 1.	1 Dorset Ram Lamb,	15 00
" 8.	1 " " "	15 00
" 15.	1 Dorset Lamb, dressed,	5 75
" 29.	1 Dorset Ram Lamb,	12 00
May 16.	Wool sold,	15 12
June 7.	2 Dorset Ewes, 1 Ram Lamb,	112 00
	Total from Agritultural Department,	$190 87

FROM HORTICULTURAL DEPARTMENT.

1889.		
Feb. 28.	Hauling Fuel,	$ 22 41
" 11.	Overcharge on Feed Bill,	1 00
Apr. 1.	Hauling Fuel,	45 17
" 15.	" "	34 80
	Total from Horticultural Department,	$103 38

EXPENDITURES.

FOR SALARIES.

1888.		
Oct. 1.	I. P. Roberts, Director, 1 qr.,	$ 375 00
" 1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
" 1.	L. H. Bailey, Horticulturist, ½ qr.,	250 00
" 1.	James M. Drew, Asst. Agr., 1 qr.,	187 50
" 1.	Wm. P. Cutter, Asst. Chemist, 1 qr.,	187 50
" 1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	187 50
" 1.	W. W. Rowlee, Asst. Botanist, 6 days,	12 50
1889.		
Jan. 1.	I. P. Roberts, Director, 1 qr.,	375 00
" 1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
" 1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
" 1.	James M. Drew, Asst. Agr., 1 qr.,	187 50
" 1.	Wm. P. Cutter, Asst. Chemist, 1 qr.,	187 50
" 1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	187 50
" 1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	187 50
	Amount carried forward,	$3,825 00

		Amount brought forward,	$3,825 00
Apr.	1.	I. P. Roberts, Director, 1 qr.,	375 00
"	1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	1.	James M. Drew, Asst. Agr., 2⅔ months,	166 67
"	1.	Wm. P. Cutter, Asst. Chemist, 1 qr.,	187 50
"	1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	187 50
"	1.	W. M. Munson, Asst. Horticulturist, 1 qr.,	187 50
"	1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	187 50
July	1.	I. P. Roberts, Director, 1 qr.,	375 00
"	1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	1.	Ed Tarbell, Asst. Agr., 1 qr.,	93 75
"	1.	Wm. P. Cutter, Asst. Chemist, 1 qr.,	187 50
"	1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	187 50
"	1.	W. M. Munson, Asst. Horticulturist, 1 qr.,	187 50
"	1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	187 50
		Total for Salaries,	$8,335 42

FOR BUILDINGS.

1889.			
Jan.	11.	Martin Gibbons, Labor,	$ 4 57
"	11.	John Mullehey, Labor,	4 99
"	11.	Wm. Cunningham, Labor,	2 47
"	11.	John Gaherty, Labor,	1 42
"	11.	Martin Solon, Labor,	4 57
"	12.	John Hennessey, Labor,	2 70
"	21.	Thomas Quilk, Labor,	11 25
"	21.	Dennis Connor, Labor,	9 19
"	28.	Jamieson & McKinney, Iron pipe,	9 16
Feb.	4.	Patrick Higgins, Labor,	1 50
Jan.	30.	George Small, Lumber,	59 72
Feb.	15.	Adams Express Co., Expressage,	25
"	26.	Thomas Quilk, Labor,	2 70
"	26.	Patrick Higgins, Labor,	1 42
Mar.	2.	D. S. Slaight, Labor,	8 40
Feb.	18.	Pay Roll,	72 75
Mar.	26.	D. S. Slaight, Labor,	10 20
"	26.	H. W. Smith, Labor,	1 35
Feb.	19.	George Small, Lumber,	39 89
Mar.	28.	Treman, King & Co., Paint,	5 77
Feb.	14.	" " Paint and hardware,	42 39
"	1.	" " Sash and hardware,	106 22
Apr.	1.	Herendeen Mfg. Co., Steam heating contract,	300 00
June	26.	Driscoll Bros., Mason work,	35 00
"	28.	Jamieson & McKinney, Repairs, Insectary,	12 12
		Total for Buildings,	$750 00

FOR PRINTING.

1888.			
July	12.	U. S. Express Co., Expressage on plates, Bull. II.,	$ 1 15
Aug.	1.	Adams Express Co., Expressage on plates, Bull. II.,	4 65
"	17.	Andrus & Church, Erratum slips and postals,	7 75
Nov.	12.	U. S. Express Co., Expressage Bull. III.,	25
"	23.	Crosscup & West, Eng. Co., Plate, Bull. III.,	19 00
		Amount carried forward,	$ 32 80

	Amount brought forward,	$ 32 80
Nov. 26.	Adams Express Co., Expressage, ...	35
Dec. 11.	Anna B. Comstock, Drawings, Bull. III., ...	52 50
1889.		
Jan. 3.	E. C. & N. Railroad, Freight on Bull. III., ...	2 30
" 10.	Crosscup & West Eng. Co., Plate, Bull. IV., ...	22 00
" 12.	Adams Express Co., Expressage on plate, ...	35
1888.		
Dec. 28.	Theodore L. DeVinne & Co., Press work, Bull. III., . .	103 00
1889.		
Jan. 26.	Andrus & Church, Eratum Slips Bulletin IV., ...	3 50
1888.		
Dec. 18.	The Lovejoy Co., Electrotyping Bulletin III., ...	37 36
" 18.	" " " Extra Electros, ...	3 39
1889.		
Feb. 4.	U. S. Express Co., Expressage Bulletin III., ...	50
" 15.	Andrus & Church, 10,000 copies Bulletin IV., ...	165 00
" 18.	Andrus & Church, 625 copies Annual Report, ...	183 27
" 28.	Andrus & Church, 2,000 copies Bulletin III., 2d Ed., . .	45 46
Mar. 28.	W. O. Kerr, Negative Shipping Case, ...	50
Apr. 13.	Crosscup & West Eng. Co., Plates Bulletin V., ...	64 00
May 13.	Andrus & Church, 10,000 copies Bulletin V., ...	157 60
June 22.	Andrus & Church, 7,000 copies Bulletin VI., ...	69 40
" 5.	Lewis Eng. Co., 5 Plates Bulletin VII., ...	6 50
" 24.	" " 5 " " "	4 50
" 15.	Anna B. Comstock, Drawings Bulletin VII., ...	20 35
" 28.	Andrus & Church, 8,000 copies Bulletin VII., ...	275 00
" 29.	Tennessee Agr. Exp. Station, 2,000 copies Bulletin II., .	30 00
" 27.	Anna B. Comstock, Drawings Bulletin IX., ...	27 00
	Total for Printing, ...	$1,306 63

FOR OFFICE EXPENSES.

1888.		
July 23.	I. P. Roberts, Ink, ...	$ 65
" 23.	Andrus & Church, 100 Sheets Carbon Paper, ...	4 00
" 9.	Andrus & Church, 5,000 Bristol Slips, ...	9 25
" 6.	Andrus & Church, Mem. Books, ...	25
Oct. 1.	A. E. Moore, 67 hrs. work, ...	10 05
" 8.	U. S. Express Co., Expressage, ...	25
" 6.	Ithaca Gas Light Co., Gas, July, ...	19
" 13.	U. S. Express Co., Expressage, ...	25
Sept. 26.	R. Friedlaender & Sohn, Landw. Kalendar, ...	83
Oct. 12.	E. & H. T. Anthony & Co., 5 Boxes Sentz. Paper, . . .	4 50
" 20.	Andrus & Church, 500 Bill Heads, ...	1 95
" 29.	A. Blakeslee, Office Signs, ...	4 25
Nov. 7.	Ithaca Gas Light Co., Gas, Oct.	19
" 30.	Raynor & Martin, 20,000 Manilla Envelopes, ...	63 00
" 9.	Andrus & Church, 1,000 Order Slips, ...	2 00
Oct. 31.	D. L. & W. R. R. Co., Freight on Envelopes, ...	1 82
Nov. 22.	Bush & Dean, 15 yds. Ribbon, ...	1 00
" 24.	Andrus & Church, Special Ruled Paper, ...	1 00
" 26.	Western Union Telegraph, 2 Messages, ...	50
" 27.	U. S. Express Co., Expressage, ...	55
Dec. 4.	Naughton Bros., Matches, ...	50
" 7.	Ithaca Gas Light Co., Gas, Nov., ...	60
	Amount carried forward,	$ 107 58

		Amount brought forward,	$ 107 58
Dec.	6.	Andrus & Church, 300 Circulars,	6 50
Oct.	19.	I. P. Roberts, Delivery of Telegram,	15
Dec.	20.	National Express Co., Expressage,	25
1889.			
Jan.	4.	Ithaca Gas Light Co., Gas, Dec.,	19
"	7.	U. S. Express Co., Expressage,	25
"	1.	Andrus & Church, Rubber Stamps,	2 50
"	14.	Andrus & Church, Letter Heads and Postals,	6 55
"	19.	Postmaster, 500 2ct. Stamps,	10 00
"	21.	Andrus & Church, Mem. Pads,	1 50
"	25.	Andrus & Church, Waste Basket,	80
Feb.	1.	A. E. Moore, Labor,	3 97
"	1.	H. N. Reid, Labor,	5 90
Jan.	31.	National Express Co., Expressage,	40
Feb.	5.	Ithaca Gas Light Co., Gas, Jan.	40
"	6.	Andrus & Church, 100 Circulars,	1 50
Jan.	5.	I. P. Roberts, Expenses to Knoxville Convention,	65 00
Feb.	9.	James M. Drew, Expenses to Geneva,	2 70
"	15.	Andrus & Church, Paid Expressage,	75
"	16.	Andrus & Church, Paid Expressage,	45
"	21.	National Express Co., Expressage,	50
"	22.	Andrus & Church, Letter Copying Book and Twine,	2 10
"	23.	Andrus & Church, 1,000 Printed Slips,	1 25
Mar.	1.	H. N. Reid, Labor,	2 25
"	5.	Ithaca Gas Light Co., Gas, Feb.,	57
"	2.	Andrus & Church, Bookbinding,	1 65
"	4.	U. S. Express Co., Expressage,	25
"	7.	W. O. Wyckoff, Typewriter Ribbon,	50
"	10.	U. S. Express Co., Expressage,	40
"	14.	Postmaster, Stamps,	25 00
"	13.	Andrus & Church, 5,000 Bristol Slips,	8 00
"	18.	T. R. Fife, Labor,	11 85
"	26.	U. S. Express Co., Expressage,	25
"	18.	George Bradley, Labor,	2 70
"	18.	Charles Moore, Labor,	4 20
"	29.	A. E. Moore, Labor,	2 03
Feb.	27.	W. U. Telegraph Co., Message,	25
Apr.	5.	Ithaca Gas Light Co., Gas, March,	38
"	11.	Andrus & Church, 2,500 Mem. Slips,	4 00
"	13.	Andrus & Church, 20,000 Manilla Envelopes,	62 00
"	16.	Edwin M. Hall, Matting,	6 51
"	18.	Adams Express Co., Expressage	95
May	1.	James Seaman, Carpenter Work and Material,	13 72
"	4.	Andrus & Church, 50 Circulars,	2 00
May	7.	Ithaca Gas Light Co., Gas, April,	76
"	11.	Andrus & Church, Two Bill Files,	12
"	20.	T. R. Fife, Labor,	11 63
"	21.	National Express Co., Expressage,	60
"	23.	U. S. Express Co., Expressage,	30
"	18.	A. B. Dick Co., Edison Mineograph,	20 00
"	22.	Andrus & Church, Paper,	1 75
"	29.	U. S. Express Co., Expressage,	30
"	31.	A. B. Dick Co., ½ ream Spec. Ruled Paper,	6 50
June	3.	C. W. Matthews, Labor,	75
"	1.	H. N. Reid, labor,	1 65
		Amount carried forward,	$ 415 01

		Amount brought forward,	$ 415 01
June	5.	Ithaca Gas Light Co., Gas, May,	57
"	7.	Andrus & Church, 5,000 Envelopes,	12 50
"	7.	E. C. Cleaves, Photographs,	2 00
"	10.	Andrus & Church, Paper Fasteners,	50
"	11.	George Bradley, Labor,	22
"	22.	A. E. Moore, Labor,	90
"	11.	Treman, King & Co., Shears,	1 50
"	28.	W. U. Telegraph Co., 2 Messages,	89
"	29.	H. N. Reid, Labor,	2 25
		Total for Office Expenses,	$436 34

FOR AGRICULTURAL DEPARTMENT.

1888.			
July	17.	I. P. Roberts, 6 samples Paris Green,	$ 92
Aug.	3.	I. P. Roberts, Telegram,	54
"	4.	D. L. W. R. R. Co., Freight on Holsteins,	17 50
"	6.	I. P. Roberts, Telegram,	50
"	14.	National Express Co., Expressage,	45
"	27.	I. P. Roberts, Expenses to Brentwood, L. I.,	23 96
"	27.	" " Cleveland, O.,	29 44
"	31.	" " Montezuma, N. Y.,	10 50
"	31.	U. S. Express Co., Expressage,	35
Sept.	1.	C. U. Farm, Labor,	56 15
July	11.	Jameison & McKinney, Plumbing,	2 55
Aug.	14.	Smiths, Powell & Lamb, Attendant's Expenses,	6 79
Sept.	1.	Treman, King & Co , Plow Point,	50
"	4.	Washington Glass Co., 2 Shades.	2 00
"	15.	W. E. Martin, 2 Hogs,	21 50
"	22.	U. S. Express Co., Expressage,	50
"	18.	National " "	50
Sept.	19.	R. H. Brown, 5 Sheep,	13 75
"	28.	E. & H. T. Anthony & Co., Photo. Developer,	3 10
"	29.	U. S. Express Co., Expressage,	75
"	29.	James E. Rice, Labor,	5 70
Oct.	1.	C. U. Farm, Labor,	7 30
Sept.	3.	Treman, King & Co., Hardware Sundries,	4 75
May	16.	C. B. Strong, Labor,	3 26
Oct.	3.	Treman, King & Co., Hardware Sundries,	6 50
"	27.	Dennis Letts, Shearing Sheep,	1 50
Nov.	1.	C. U. Farm, Labor,	1 75
"	16.	F. B. Fargo &. Co., Short's Milk Tester,	12 80
"	19.	Adams Express Co., Expressage,	1 80
"	27.	W. J. Ellis, 12 Young Sheep,	34 00
Dec.	3.	D. L. & W. R R. Co., Freight,	2 20
"	8.	Jamieson & McKinney, Plumbing,	34 18
1889.			
Jan.	8.	W. J. Ellis, 3 Sheep.	14 00
"	12.	Condimental Food Co., 25 lbs. Cond. Food,	1 25
Feb.	1.	C. U. Farm, Labor,	2 75
Jan.	19.	E. C. & N. R. R., Freight,	40
Feb.	8.	Charles Moore, Labor,	8 25
"	14.	U. S. Express Co., Expressage,	60
"	13.	National Express Co., Expressage,	30
Mar.	1.	C. U. Farm, Labor,	2 50
Apr.	1.	C. U. Farm, Labor,	10 80
		Amount brought forward,	$ 348 84

		Amount brought forward,	$ 348 84
Apr.	6.	I. P. Roberts, Expenses to Truxton,	5 00
Mar.	1.	Jamieson & McKinney, Plumbing,	4 46
Apr.	12.	Ed Tarbell, Labor,	10 80
"	12.	Adams Express Co., Expressage,	35
"	11.	U. S. Express Co., Expressage,	95
"	16.	National Express Co., Expressage,	65
"	18.	U. S. Express Co., Expressage,	30
"	18.	National Express Co., Expressage,	30
"	8.	A. D. Perry & Co., Seed Corn,	25
"	5.	Z. DeForest Ely & Co., Seed Corn,	55
Mar.	8.	Treman, King & Co., Hardware Sundries,	27 37
Apr.	26.	E. C. & N. R. R. Co., Freight,	55
"	26.	H. H. Wing, Photo. Materials,	25
"	30.	U. S. Express Co., Expressage,	45
May	1.	James Seaman, Carpenter Work and Material,	16 30
Mar.	19.	Edward G. Allen, Subscription to Periodicals,	1 25
Apr.	29.	Jos. Breck & Sons, Seed Corn,	70
May	1.	C. U. Farm, Labor,	12 92
"	6.	Rothschild Bros., Cheese Cloth,	50
"	11.	D. L. & W. R R. Co., Freight,	40
May	23.	E. & H. T Anthony & Co., Ground Glass,	33
"	21.	Symmes Hay Cap Co., 40 Hay Caps,	9 34
June	1.	C. U. Farm, Labor,	18 74
"	15.	" " Feed for Sheep,	87 03
May	2.	Geo. Rankin & Son, Dishes,	1 50
"	3.	Treman, King & Co., Galvanized oven,	10 25
June	30.	C. U. Farm, Labor,	4 73
"	29.	Jas. Seaman, Carpenter work,	60
"	29.	C. U. Farm, Cotton Seed Meal and Bran,	40 56
		Total for Agricultural Department,	$606 22

FOR HORTICULTURAL DEPARTMENT.

1888.			
July	27.	E. W. Solies, 1 load Manure,	$ 40
Aug.	1.	H. D. Frear, 9 " "	3 15
"	6.	John Sincebaugh, 8 loads Manure,	3 20
"	6.	E. C. & N. R. R., Freight on Books,	12 58
"	21.	National Express Co., Expressage,	1 05
June	30.	E. & H. T. Anthony & Co., Photograph outfit,	96 32
Aug.	4.	L. H. Bailey, Fruit Seeds,	40 05
"	1.	C. U. Farm, Labor,	59 13
Sept.	1.	" " "	16 63
July	30.	Dunn & Hill, 2 Locks,	7 00
May	24.	Fairbanks & Co., Scales,	10 85
Sept.	1.	Treman, King & Co., 6 Plow Points,	2 50
June	29.	Gustav E. Stechert, Books,	110 00
Oct.	3.	B. W. Ross & Co., 9 loads Manure,	3 15
Aug.	24.	J. Carbutt, Negatives,	35 35
Sept.	29.	Gustav E. Stechert, Subs't to Jour.,	5 20
Oct.	3.	I. H. Dallmeyer, Photo Lens,	39 20
"	22.	National Express Co., Expressage,	2 60
Sept.	27.	John Wheldon, Books,	133 88
"	21.	J. F. Moore, Horse-blankets, etc.,	13 05
Oct.	31.	Cornell University, Cultivating,	9 00
Nov.	1.	Tice & Lynch, Custom House Brokerage,	12 28
		Amount carried forward,	$ 616 57

		Amount brought forward,	$ 616 57
Oct.	12.	Gustav E. Stechert, Books,	2 00
"	26.	Chas. H. Hillick, Book Binding,	28 31
"	31.	G. B. Bracket, Iowa Hort. Rep.,	5 00
Nov.	15.	D. L. & W. R. R., Freight,	1 30
"	15.	Chas. H. Hillick, Book Binding,	18 27
"	16.	Adams Exp. Co., Expressing Custom House Brokerage,	4 00
Oct.	16.	H. E. Van Deman, 200 Juneberry Plants,	12 00
1889.			
Mar.	1.	Pay Roll, Labor,	28 14
1888.			
Dec.	15.	Cornell University, Cultivating Nursery,	10 00
"	12.	Charles H. Hillick, Binding Books,	5 72
Aug.	20.	C. M. Chapman, 6 Loads Manure,	2 40
Dec.	31.	L. H. Bailey, Stationery,	10 13
1889.			
Jan.	11.	Martin Gibbons, Labor,	2 14
"	11.	John Mullehey, Labor,	2 14
"	11.	Martin Solon, Labor,	72
"	11.	Wm. Cunningham, Labor,	2 55
"	11.	John Gaherty, Labor,	2 22
"	12.	John Hennessey, Labor,	4 42
"	19.	U. S. Express Co., Expressage,	30
"	1.	C. U. Farm, Labor,	2 62
"	19.	National Express Co., Expressage,	40
"	21.	Thomas Quilk, Labor,	12 30
"	21.	Dennis Connor, Labor,	13 62
"	19.	Patrick Higgins, Labor,	7 13
"	21.	Martin Gibbons, Labor,	6 15
"	29.	J. W. Cline, 104¾ bu. Oats,	41 90
"	10.	H. Bool, Office Furniture,	24 98
"	10.	W. Atlee Burpee & Co., Seeds,	3 83
"	31.	J. R. Comings, 14 Loads Manure,	5 60
Feb.	1.	Frank Knettles, Labor,	22 88
"	1.	L. H. Bailey. Sundries,	10 30
Jan.	28.	U. S. Express Co., Expressage,	45
Feb.	4.	D. L. & W. R. R., Freight,	5 10
Jan.	30.	George Small, Lumber,	40 00
"	12.	A. M. Hull, 1,000 lbs. Feed,	11 00
"	14.	J. E. Van Natta, 50 bu. Oats,	20 00
"	15.	Haskin & Todd, 2 gals. Astral Oil,	44
"	14.	C. S. Wattles, 1 bbl, Salt,	1 25
"	14.	Joseph Fowles, 165 2-inch Tile,	3 30
Feb.	6.	Andrus & Church, Stationery,	21 08
"	9.	Henry Smith, 5 Loads Manure,	2 00
"	8.	Andrus & Church, 200 Circulars and Envelopes,	3 50
"	7.	National Express Co., Expressage,	2 95
Jan.	31.	Atkins & Durbrow, 1 ton Peat Moss,	14 00
Feb.	14.	Andrus & Church, Labels,	2 56
"	19.	A. I. Root, Transplanting Tubes,	50
"	19.	Z. K. Jewett, 5 bales Sphagnum,	8 00
"	19.	Andrus & Church, Ink,	56
Jan.	5.	James F. Moore, Repairing Harness,	75
Feb.	28.	L. H. Bailey, Postage,	4 25
"	26.	Thomas Quilk, Labor,	5 10
Mar.	4.	J. Reed, 1 Load Manure,	40
		Amount carried forward,	$ 1,057 23

		Amount brought forward,	$ 1,057 23
Feb.	13.	Peter Henderson & Co., Seed,	1 00
"	12.	Eimer & Amend, Apparatus,	4 60
"	28.	D. L. & W. R. R. Co., Freight,	5 22
Mar.	5.	F. W. Smith, 2 Portfolios,	3 00
"	5.	National Express Co., Expressage,	40
"	6.	J. C. Vaughan, Seeds,	5 00
Feb.	18.	Pay Roll, labor,	12 50
Mar.	6.	L. H. Bailey, Expressage,	4 05
"	6.	U. S. Express Co., Expressage,	2 15
"	6.	National Express Co., Expressage,	70
"	8.	L. H. Bailey, Expressage,	30
"	9.	National Express Co., Expressage,	30
"	11.	U. S. Express Co., Expressage,	30
"	8.	Dennison Manufacturing Co., Fish Glue,	70
"	6.	Judson & Co., 5 lbs. Raffia,	75
"	11.	T. V. Munson, Plants,	15 00
"	11.	National Express Co., Expressage,	40
Jan.	26.	Vilmorin, Andrieux & Co., Seeds,	14 68
"	26.	Becker Bros., Balance,	11 44
Mar.	14.	National Express Co., Expressage,	60
"	8.	Gould's Manufacturing Co., 2 Rubber Nozzles,	78
"	13.	J. M. Thorburn & Co., Seeds,	6 24
"	11.	Peter Henderson & Co., Seeds,	5 85
"	11.	National Express Co., Expressage,	50
"	21.	" " " "	25
"	18.	Andrus & Church, Stationery,	27
Feb.	6.	J. C. Vaughan, Seeds,	5 64
Mar.	26.	W. M. Munson, Sundries,	1 27
"	18.	National Express Co., Expressage,	60
"	26.	D. S. Slaight, Labor,	3 00
Feb.	21.	George Small, Lumber,	3 45
Mar.	1.	Treman, King & Co., Hardware Sundries,	1 65
Feb.	14.	" " " " "	10 33
"	1.	" " " " "	36 73
Mar.	1.	Jamieson & McKinney, 12 ft. Hose,	12 50
"	4.	J. M. Thorburn & Co., Seeds,	53
"	16.	Automatic Electric Co., Repairs to Incubator,	8 20
Feb.	11.	J. C. Vaughan, Seeds,	1 38
Mar.	25.	U. S. Express Co., Expressage,	30
"	18.	A. M. Hull, 1,000 lbs. Feed,	9 50
"	15.	Green's Nursery Co., Plants,	6 00
"	27.	Andrus & Church, Tracing Linen,	80
"	12.	Treman, King & Co., Hardware Sundries,	4 39
"	25.	John Lewis Childs, Plants,	4 00
Apr.	1.	U. S. Express Co., Expressage,	65
Mar.	28.	Andrus & Church, Pens and Pencils,	40
Apr.	1.	Wm. Wescott, Labor,	35 00
Mar.	12.	Burns Bros., Blacksmithing,	12 25
"	20.	H. Hill, Coal,	25 62
Apr.	1.	Ithaca Glass Works, 2050 lbs. Sand,	3 23
Mar.	30.	H. W. Smith, Labor,	7 50
Apr.	3.	National Express Co., Expressage,	1 15
Mar.	26.	" " " "	35
Apr.	5.	W. M. Munson, Sundries	6 45
"	2.	Andrus & Church, Mounting Paper,	4 50
		Amount carried forward,	$ 1,361 58

		Amount brought forward,	$ 1,361 58
Apr.	6.	Andrus & Church, Circulars,	6 96
"	6.	Andrus & Church, Stationery,	78
"	6.	L. H. Bailey, Sundries,	3 65
"	6.	Charles Cleveland, Labor,	7 50
"	3.	DeLandreth & Sons, Seeds,	1 25
"	5.	Jamieson & McKinney, Plumbing,	23 79
"	6.	Judson & Co., 2,000 Pot Labels,	92
"	9.	National Express Co., Expressage,	30
"	12.	Adams Express Co., Expressage,	50
"	12.	L. H. Bailey, Postage,	8 00
"	12.	Johnson & Stokes, Seeds,	1 78
"	12.	C. Rich, Huckleberry Plants,	5 50
"	1.	D. S. Slaight, Making Shades,	1 00
"	11.	T. H. Hoskins, Seeds,	1 75
"	11.	D. Bogue, Trees,	17 20
"	15.	National Express Co., Expressage,	1 80
"	13.	Barr Bros., 6 Plow Points,	3 00
"	15.	L. V. R. R., Freight,	75
"	22.	National Express Co., Expressage,	60
"	18.	U. S. Express Co., Expressage,	2 05
"	18.	Adams Express Co., Expressage,	2 30
"	18.	Mecke & Co., Custom House Brokerage,	6 04
"	15.	E. & H. T. Anthony & Co., Photo. Apparatus,	47 65
"	17.	" " " " " "	3 53
"	19.	" " " " " "	1 42
"	23.	Treman, King & Co , Hot-bed Sash,	6 08
"	20.	Burns Bros., Blacksmithing,	6 30
"	24.	E. C. & N. R. R., Freight,	1 47
"	26.	H. W. Smith, Labor,	7 05
"	25.	U. S. Express Co., Expressage,	50
"	25.	I. Brewer, Trees,	22 00
"	16.	Lewis Roesch, Grapevines,	10 00
"	11.	H. Bool, Table,	7 00
Apr.	24.	Andrus & Church, Circulars and Envelopes,	2 31
"	27.	L. H. Bailey, Trees and Expenses,	67 78
"	27.	A. Tompkins, 6 Loads Manure,	2 40
"	25.	Jamieson & McKinney, Sewer Pipe,	3 24
"	27.	T. R. Fife, Labor,	7 88
"	25.	Andrus & Church. Envelopes,	90
"	20.	George Small, 500 Pickets,	2 50
"	24.	J. M. Thorburn & Co., Seeds,	90
"	24.	Duane H. Nash, Repairs to Harrow,	1 35
1888.			
Aug.	23.	E. & H. T. Anthony & Co., Photo Material,	8 33
1889.			
Apr.	29.	George Small, 500 Brick,	5 00
May	1.	James Seaman, Carpenter Work and Material,	8 98
Apr.	29.	Johnson & Stokes, Peach Pits,	2 00
"	20.	Harmon Hill, Coal,	20 33
"	2.	Jamieson & McKinney, Sewer Pipe,	1 00
"	20.	Eimer & Amend, Bell Glass,	2 40
"	27.	Eimer & Amend, Rubber Tubing,	57
"	29.	Andrus & Church, 300 Postal Cards and Printing,	3 75
May	1.	Pay Roll, Labor,	78 30
"	1.	Gustav E. Stechert, Books,	5 94
		Amount carried forward,	$ 1,797 86

		Amount brought forward,	$ 1,797 86
Mar.	29.	Gustav E. Stechert, Books,	9 75
"	19.	Edward G. Allen, Books,	58 68
May	1.	C. U. Farm, Labor,	2 28
Apr.	20.	G. D. Howe, Seed Potatoes,	1 00
"	15.	J. Carbutt, Photo. Negatives,	5 40
May	6.	National Express Co., Expressage,	40
"	10.	Simon Maloney, Labor,	2 50
"	9.	Adams Express Co., Expressage,	1 00
"	9.	National Express Co., Expressage,	65
"	27.	U. S. Express Co., Expressage,	1 50
"	3.	Eimer & Amend, Thermometers,	5 00
"	6.	Andrus & Church, Paper,	2 00
"	6.	James W. Queen & Co., Camera Lucida,	3 38
"	25.	W. M. Munson, Sundries,	2 05
"	31.	Pay Roll, Labor,	119 22
"	20.	Burns Bros., Blacksmithing,	6 45
"	31.	National Express Co., Expressage,	1 80
June	1.	T. R. Fife, Labor,	6 90
"	15.	H. W. Smith, Labor,	7 50
"	21.	A. E. Moore, Labor,	4 05
"	15.	National Express Co., Expressage,	90
May	14.	W. H. Cornish & Co., Seeds,	2 95
Apr.	17.	G. H. & J. H. Hale, Strawberry Plants,	28 13
"	13.	J. F. Moore, Harness Repairs,	7 50
"	27.	Ellwanger & Barry, Plants,	17 16
May	8.	A. M. Hull, 1,000 lbs. Feed,	10 00
"	28.	J. M. Thorburn & Co., Seeds,	1 62
"	28.	Judson & Co , 500 pkg. Labels,	63
"	23.	Farmers' Fertilizer Co., Fertilizer,	20 00
"	13.	T. J. Wilson, 1 Case,	6 00
Apr.	25.	D. Laughton, Ground Bone,	4 58
May	8.	Straiton & Storms, Tobacco stems,	4 00
June	17.	C. H. Howes, Printing Photographs,	1 84
May	6.	J. M. Thorburn & Co., Grass Seed,	2 68
June	30.	Pay Roll, Labor,	75 69
"	1.	Jamieson & McKinney, Plumbing,	7 28
"	21.	Andrus & Church, Tablets,	25
"	28.	W. M. Munson, Sundries,	85
"	10.	Treman, King & Co., Hardware Sundries,	40 24
May	28.	Edward G. Allen, Books,	119 30
"	24.	Gustav E. Stechert, Books,	5 20
"	28.	" " " "	10 92
June	12.	L. H. Bailey, Traveling Expenses,	39 90
"	12.	H. Bool, Curtain Fixtures,	15 44
"	29.	Andrus & Church, Stationery,	2 75
"	28.	J. M. Thorburn & Co., Seeds,	35
"	29.	H. S. Williams, Lumber,	5 00
"	29.	S. B. Buck, 2,300 lbs. Feed,	23 00
		Total for Horticultural Department,	$2,493 53

FOR ENTOMOLOGICAL DEPARTMENT.

1888.			
July	2.	National Express Co., Expressage,	$ 30
"	2.	" " " "	65
Sept.	15.	D. L. & W. R. R., Freight,	1 35
		Amount carried forward,	$ 2 30

		Amount brought forward,	$ 2 30
Aug.	30.	E. & H. T. Anthony & Co., Photo. Material,	50
July	11.	C. T. Stephens, Seeds,	2 45
Sept.	1.	Treman, King & Co., Sundries,	3 45
Aug.	22.	National Express Co., Expressage,	25
"	28.	Peter Henderson & Co., Plants,	1 84
"	8.	Bausch & Lomb Opt. Co., Microscopic Sund.,	15 28
"	29.	J. H. Comstock, Traveling Expenses to L. I.,	23 87
"	29.	" " " " " Rochester,	13 66
"	29.	" " Sundries,	5 26
Sept.	25.	James E. Rice, Labor,	17 70
"	5.	U. S. Express Co., Expressage,	70
Aug.	21.	" " " "	25
Sept.	28.	Treman, King & Co., Door Springs,	1 45
"	28.	E. & H. T. Anthony & Co., Photo. Material,	3 10
July	16.	E. S. Becker, Sundries,	2 03
"	13.	George E. Meigs, Telephone,	30 00
June	7.	White & Burdick, Ether,	1 20
Oct.	9.	H. Bool, Curtain Fixtures,	12 80
Nov.	22.	James Osborn, Cartage,	50
June	12.	E. C. & N. R. R., Freight,	1 75
Oct.	15.	Treman, King & Co., Sundries,	2 25
Dec.	10.	National Express Co., Expressage,	40
1889.			
Jan.	1.	C. U. Farm, Labor,	1 75
Feb.	1.	M. V Slingerland, Labor,	7 00
Mar.	2.	U. S. Express Co., Expressage,	2 25
"	13.	M. V. Slingerland, Labor,	4 00
Apr.	1.	" " "	5 50
"	19.	White & Burdick, 15 gr. Chlor. Gold,	50
"	11.	Andrus & Church, Printing 200 Cards,	1 25
May	1.	James Seaman, Carpenter Work and Material,	4 81
Apr.	27.	Gauntlet & Brooks, Chemicals,	1 00
"	27.	Andrus & Church, Ink,	1 45
"	20.	Andrus & Church, Letter Heads,	2 15
May	1.	M. V. Slingerland, Labor,	13 95
"	3.	National Express Co., Expressage,	25
"	15.	W. J. Ellis 40 Hop Poles,	4 00
"	27.	U. S. Express Co., Expressage,	40
"	16.	W. O. Kerr, Carpenter Work and Material,	10 58
June	6.	Frost & Brown, Kerosene Oil,	5 09
"	5.	J. H. Comstock, Sundries,	9 95
"	18.	Frost & Brown, Kerosene Oil,	63
May	21.	Treman, King & Co., Hardware Sundries,	11 86
June	21.	J. C. Stowell & Son. Kerosene Oil,	6 90
"	27.	M. J. Holmes, Labor,	7 20
"	27.	Jennie Fleming, labor,	15 00
		Total for Entomological Department,	$260 46

FOR BOTANICAL DEPARTMENT.

Sept.	28.	Adams Express Co., Expressage,	$ 70
June	30.	Eimer & Amend, 1 Platinum Dish,	5 08
Nov.	8.	Andrus & Church, 500 Circulars and Envelopes,	7 05
"	13.	A. N. Prentiss, Postage,	18 00
"	15.	Charles H. Hillick, Bookbinding,	52 48
		Amount carried forward,	$ 83 31

	Amount brought forward,	$ 83 31
Nov. 28.	Bausch & Lomb Opt. Co., Microscope material, ...	5 04
1889.		
Jan. 28.	Eimer & Amend, Thermometers, ...	7 72
Feb. 18.	D. L. & W. R. R., Freight, ...	2 22
Mar. 7.	W. O. Kerr, Case and Table, ...	100 00
" 28.	" Carpenter work and Material, ...	121 11
Apr. 18.	U. S. Express, Expressage, ...	1 85
1888.		
Nov. 13.	W. A. Kellerman, Specimens, ...	1 92
1889.		
Apr. 15.	Ellwanger & Barry, Strawberry Plants, ...	80
" 29.	W. R. Dudley, Postage, ...	5 00
1888.		
Dec. 22.	Ithaca Democrat, Envelopes and Blanks, ...	10 75
1889.		
Apr. 24.	H. Bool, Office Furniture, ...	9 86
May 1.	W. O. Kerr, Carpenter work and Material, ...	90 85
" 24.	" Book and Herbarum case, ...	55 00
" 16.	E. D. Baright, Labor, ...	56 70
" 30.	Andrus & Church, Mounting Paper, ...	31 80
June 18.	W. O. Kerr, 12 Cabinet Boxes, ...	13 20
	Total for Botanical Department, ...	$597 13

FOR CHEMICAL DEPARTMENT.

July 4.	U. S. Express Co., Expressage, ...	$ 35
" 26.	National " "	55
Sept. 21.	Andrus & Church, Blank Books, ...	4 00
1889.		
Jan. 16.	Eimer & Amend, Apparatus, ...	1 50
Feb. 5.	U. S. Express Co., ...	35
Jan. 19.	C. Carmody, Labor, ...	3 75
Feb. 8.	G. C. Caldwell, Postage, ...	3 00
" 4.	Emil Greiner, Apparatus, ...	5 25
Jan. 28.	Eimer & Amend, Glass wool, ...	9 60
Feb. 18.	National Express, Expressage, ...	25
" 19.	Eimer & Amend, Apparatus, ...	1 25
" 20.	Andrus & Church, Blanks, ...	3 25
" 27.	Eimer & Amend, 2 Bunsen Burners, ...	80
Apr. 12.	Adams Express, ...	25
Jan. 28.	Treman, King & Co., Labor and Material, ...	6 75
May 1.	Jas. Seaman, Carpenter work and Material, ...	5 57
" 15.	D. W. Colby, Assistant in Laboratory, ...	60 00
May 10.	Eimer & Amend, Platinum wire, ...	18 92
" 10.	Andrus & Church, Gum Labels, ...	1 00
" 27.	W. P. Cutter, Expenses to Geneva, ...	2 44
" 31.	National Express, Expressage, ...	55
" 28.	Emil Greiner, Short's Milk tester, ...	13 00
June 4.	D. W. Colby, Assistant in Laboratory, ...	60 00
Feb. 15.	White & Burdick, Pepsin, ...	1 25
June 6.	Andrus & Church, Blank Book, ...	1 50
" 7.	Eimer & Amend, Caustic soda, ...	22
" 8.	Baker & Adamson, Sulphuric acid, ...	8 92
	Total for Chemical Department, ...	$214 27
	Total expenditures, ...	$15,000 00